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ABSTRACT

This guide, which is one in the "Exploration" series of curriculum guides intended to assist junior high and middle school industrial educators in helping their students explore diverse industrial situations and technologies used in industry, deals with using alternate energy sources. The following topics are covered in the individual lessons: types of alternative energy sources and the current status of energy, wind energy, ocean thermal energy conversion, geothermal energy, biomass energy, water power, and nuclear energy. The fundamental operating principles, applications, advantages, and disadvantages of each energy source are discussed. The guide includes the rationale behind its development, hints to the teacher, lesson plans, student handout masters, teacher aids, a unit examination, and a list of references. The lesson plans include cross-referenced lists of objectives, lesson content, and learning activities. (MN)

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The Illinois
Plan for Industrial
Education

Illinois
State Board of
Education

Adult,
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ED2960096

USING ALTERNATE ENERGY SOURCES

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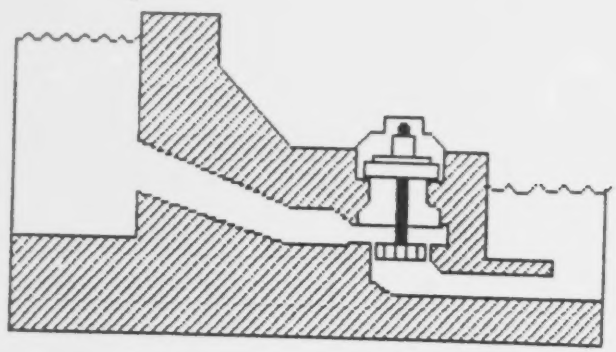
PACKET INCLUDES:

- Rationale
- Hints to the Teacher
- Lesson Plans
- Student Handout Masters
- Teacher Aides
- Unit Examination
- References



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ILLINOIS PLAN FOR INDUSTRIAL EDUCATION

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INTRODUCTION

"Using Alternate Energy Sources" is one of a series of curriculum materials developed for junior high and middle school industrial educators. Listed below are the titles of the units in the series.

Communication
- Using the Language of Industry
- Exploring Computer Technology
- Exploring Photography
- Exploring Graphic Communication
- Exploring Electronic Communication

Energy Utilization
- Exploring Solar Energy
- Using Alternate Energy Sources
- Conserving Energy Sources
- Exploring Electricity/Electronics
- Exploring Mechanical and Fluid Systems

Impact of Industry and Technology
- Recycling Materials
- Limiting Pollution
- Exploring Careers in Industry and Technology
- Exploring Technology and the Future

Production
- Exploring Materials and Processes
- Exploring Construction Technology
- Research and Development
- Exploring Manufactured Systems
- Servicing Products

Transportation
- Exploring Land Transportation Systems
- Exploring Aviation Technology
- Exploring Water Transportation Systems
- Exploring Space Transportation Systems
- Exploring Materials Handling Systems

With the Exploration Series, industrial educators can lead their 7th and 8th grade students in exploring many industrial situations and technologies used in industry. In addition, this series can serve as a resource for teachers orienting 9th and 10th grade students to industrial technologies in communication, production, energy utilization and transportation. Each unit in the series includes a rationale, hints to the teacher, a sample daily schedule, lesson plans, student handouts, teacher aids, a unit examination, and a list of references.

"Using Alternate Energy Sources" and other units in the series are available on a cost recovery basis through the Curriculum Publications Clearinghouse, Western Illinois University, Horrabin Hall 46, Macomb, IL 61455.

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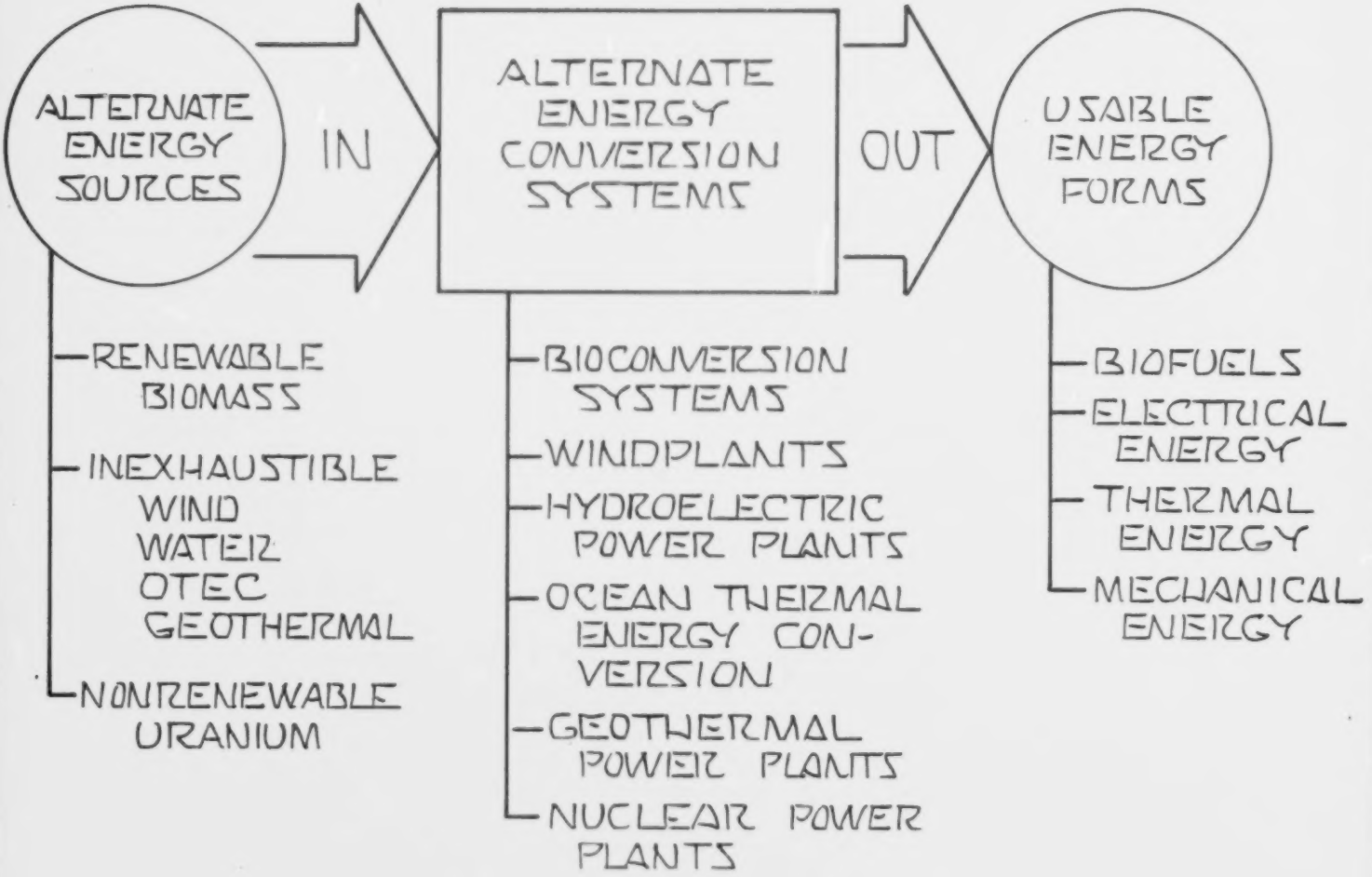

ALTERNATE ENERGY SOURCES
IN
ALTERNATE ENERGY CONVERSION SYSTEMS
OUT
USABLE ENERGY FORMS
RENEWABLE BIOMASS
INEXHAUSTIBLE WIND WATER OTEC GEOTHERMAL
NONRENEWABLE URANIUM
BIOCONVERSION SYSTEMS
WINDPLANTS
HYDROELECTRIC POWER PLANTS
OCEAN THERMAL ENERGY CONVERSION
GEOTHERMAL POWER PLANTS
NUCLEAR POWER PLANTS
BIOFUELS
ELECTRICAL ENERGY
THERMAL ENERGY
MECHANICAL ENERGY

USING ALTERNATE ENERGY SOURCES
A Rationale

Driving a bus. Producing automobiles. Running a computer. Making a telephone call. All these things take energy. Today, that energy is derived mostly from oil, coal, or natural gas -- all non-renewable fossil fuels. Although these sources have been plentiful in the past, they are dwindling and others need to be found. Alternate energy sources range from such unlikely sources as garbage and peat, to more familiar sources as the sun and the wind.

The next generation will be faced with many problems if alternatives are not developed. We need to not only think about the options confronting us, but also, to make steps towards addressing the problems and finding solutions.

Harnessing future energy sources is the focus of this unit. Students are introduced to the possibility of using such alternatives as wind, geothermal, nuclear, solar, and hydroelectric energy. They are given the opportunity to build models of energy systems and conduct experiments to demonstrate their effectiveness. "Using Alternate Energy Sources" is a broad orientation to energy problems and solutions and serves to develop student interest and knowledge about an important dilemma in today's industrial-technological society.

USING ALTERNATE ENERGY SOURCES
Hints to the Teacher

1. Solar energy is considered an alternative energy resource. However, solar energy is not included in this unit. The solar energy topic is addressed in its own unit. The topic is too large and too important to be limited to just a few lessons. Consider using the solar energy unit in your curriculum plans.

2. Most of the lessons require the teacher to make some of the components necessary for the demonstrations or projects. You will need to read each lesson carefully, acquire materials, and make the required devices prior to teaching the lesson.

3. These materials include several handouts for students to read. You may want to read the handouts and write study questions for them. The study questions should identify main ideas you feel are important.

4. Prior to implementing this lesson, consider contacting your local utility company. Many of the utility companies in Illinois have public relations programs that will provide your school with pamphlets on alternate energy sources, learning activities, films, and/or guest speakers.

5. During the biomass energy lesson, consider collaborating with your science department to construct and test pyrolytic converters and/or anaerobic digesters. Both learning activities would require supplies and cleanup facilities commonly found in science laboratories. In addition, both learning activities would reinforce biomass conversion and chemistry concepts.

6. The turbine/generator used during the geothermal and water power energy lessons may be too difficult for your students to make from scratch. Consider making the units yourself, prefabricating as many parts as possible, and/or asking older students to help you make the turbine/generator.

Unit: Using Alternate Energy Sources

Lesson 1: Introduction to Alternate Energy

Objectives	Lesson Content	Learning Activities	Ref.
A. Following a discussion, students will be able to: -identify definitions for nonrenewable, renewable, and inexhaustible energy sources. -list the three basic types of fossil fuels. -match alternative energy sources with their description. -explain the relationship between fossil fuels and the need for alternative forms of energy.	A. Alternative energy sources 1. Types of energy sources a. nonrenewable (energy sources that are in limited supply and cannot be replaced) b. renewable (energy resources that can be replenished if managed properly. c. inexhaustible (energy sources that cannot be depleted and will always be available. 2. Fossil fuels a. natural gas b. coal c. petroleum 3. Alternative energy sources a. solar energy b. wind energy c. water energy (hydroelectric, tides, waves) d. OTEC (ocean thermal energy conversion) e. bioconversion (energy from plants and waste products) f. geothermal g. nuclear	A. Teacher Guided Discussion 1. Ask students why it is important to conserve energy. 2. Using OT #1-1, define the three basic types of energy sources. 3. Using OT #1-2, discuss the three basic types of fossil fuels. 4. Using OT #1-3, discuss the seven basic types of alternate energy sources. 5. Discuss the need to conserve fossil fuels and develop alternative forms of energy.	

B. Following a demonstration, in a lab activity, students will be able to:
- -answer a pretest describing what they presently know about energy resources and their use.
- -make posters categorizing energy resources as renewable, nonrenewable, or inexhaustible.

B. Describing the current status of energy today
1. Taking a pretest
   a. What energy sources do we use most?
   b. How much energy are we using?
   c. What are we using energy for?
   d. How does the U.S. compare to other countries in terms of energy utilization?
2. Categorizing energy sources
   a. nonrenewable (fossil fuels)
   b. renewable (bioconversion)
   c. inhaustible (solar, wind, water, OTEC, and geothermal)

B. Learning Activities
1. Provide students with HO #1-2 (Energy pretest)
2. Make sure students understand that this test will not be graded and the purpose of the test is to learn how much they already know about energy sources.
3. Explain the directions for taking the pretest and have the students answer the questions.
4. When students have completed the pretest, discuss each question, provide the correct answers, and provide additional information as needed. Allow students to correct their own tests. Do not collect the test.

5. Divide your class into groups of two or three students. Provide each group with HO #1-3. Assign each group a workstation equipped with scissors and tape.
6. Demonstrate how to use the materials provided to make a poster illustrating nonrenewable, renewable, and inhaustible energy resources.
7. Have each group make their posters categorizing energy resources.
8. When students have finished, select three posters from the class and ask students why they located energy resources under their headings.
9. Allow students to correct their posters.

OT #1-1

TYPES OF ENERGY SOURCES:

* nonrenewable (energy sources that are in limited supply and cannot be replaced.
* renewable (energy sources tha can be replenished if managed properly.
* inexhaustible (energy sources that cannot be depleted and will always be available.

OT #1-2

FOSSIL FUELS:

* natural gas
* coal
* petroleum

ALTERNATE ENERGY SOURCES:

* solar energy
* wind energy
* water energy (hydroelectric, tides, waves)
* OTEC (ocean thermal energy conversion)
* bioconversion (energy from plants and waste products)..
* geothermal
* nuclear

USING ALTERNATE ENERGY SOURCES

Preparation Hints:

1. Review the materials provided, duplicate HO #1-1 and HO #1-2, and prepare the transparencies needed to present this lesson.

2. During a lab activity, your students will be making posters illustrating the three basic types of energy sources. Prior to implementing this lesson, you will need to establish work stations equipped with scissors and tape.

Content Presentation Hints:

1. When introducing students to the concepts of nonrenewable, renewable, and inexhaustible energy sources, limit your discussion to their definitions. Do not provide students with concrete examples of energy sources that characterize each category. During the lab activity, students will be reading descriptions of basic types of energy sources and categorizing under the basic types of energy sources.

2. Consider showing students a film or videotape on energy sources, fossil fuels, or alternate energy sources.

Learning Activity Hints:

1. After students have taken the pretest, discuss each question and provide the correct answer. The answers for the pretest are as follows:

    1. (C) The USA uses about one-third of the world's energy sources, but the USA has only 6 percent of the world's population.

    2. (D) The average US citizen uses from 10 to 100 times the amount of energy a citizen in a developing country uses.

    3. (A) Oil provides about half the energy used in the United States today. Coal, natural gas, nuclear, and hydroelectric account for the other half.

    4. (B) Most of the energy from oil is used in automobiles.

    5. (D) The oil, natural gas and coal we are using today, nature started forming 500 million years ago. Once these energy sources are used up, for all practical purposes, they are gone.

6. (B) The demand for energy in the United States has doubled about every 20 to 25 years for more than a century.

7. (B) Most of the energy available on the earth comes from the sun. As long as we have the sun, we cannot run out of energy. However, we are running out of fossil fuels. It is important that we learn how to use alternate energy sources before we use up the available fossil fuels.

8. (A) Current estimates state that the natural gas reserves in the US will be used up in 40 years, the oil reserves should last about 100 years, and the coal reserves will last about 500 years.

9. (B) Since 1900 more than 100,000 coal miners have been killed and more than a million have been disabled as a result of mining accidents. The pollution from coal may have killed as many as 1,150 people in London in 1911. Another air pollution incident in London is thought to have killed about 4,000 in 1952.

10. (?) The purpose of this question is to cause the student to think about their own awareness of energy use around them.

2. Before students begin making their posters review the definitions for renewable, nonrenewable and inexhaustible types of energy sources. Using OT #1-1, list the three categories on the board, define each term, and explain how the categories are different. Do not tell students what energy sources fit into each category. Divide your class into groups of two to three students and assign each group a workstation equipped with scissors and tape. Provide each student HO #1-2. Instruct students to read each energy resource description carefully. Tell students to cut out the symbols for each energy resource and locate them under the category they feel it best fits (renewable, nonrenewable, or inexhaustible). When all the energy sources have been placed under a category and they have checked to make sure they are correct, have students fasten them to the poster with tape.

3. When the students have completed their energy posters, choose three that are correct. Have individual students explain why each energy resource was placed under a given category. Allow students time to correct their poster if needed. Display the poster in the lab and/or have students keep their posters for future reference.

4. Nonrenewable energy sources are in limited supply and once their usable form has been consumed, they cannot be replaced. Examples of nonrenewable energy sources include petroleum, coal, natural gas, and uranium.

   Renewable energy sources can be replenished if managed properly. Examples of renewable energy sources include wood, plants, trash, sewage, and animal waste.

   Inexhaustible energy sources cannot be depleted and will always be available. Examples of energy sources in infinite supply include solar energy, wind energy, water power (hydroelectric, waves and tide energy), ocean thermal energy, hydrogen energy, and geothermal energy.

ENERGY UTILIZATION PRETEST

DIRECTIONS: Read each statement carefully. Circle the letter of the answer which best completes or answers the question.

1. Which of the following countries uses the most energy?

   A. U.S.S.R.
   B. Japan
   C. U.S.A.
   D. Germany

2. I use ____ times more energy than someone in a developing country.

   A. 2 or 3
   B. 4 to 6
   C. 8 to 9
   D. 10 to 100

3. Most of the energy we use comes from ___.

   A. oil
   B. natural gas
   C. coal
   D. dams

4. Most of the oil we use is used ___.

   A. to heat homes
   B. to power cars
   C. in manufacturing
   D. for lubrication

5. Fossil fuels (oil, natural gas, and coal) are being used up ___ times faster than they are being produced.

   A. 10
   B. 500
   C. 1,000
   D. 1,000,000

6. In the United States, the need for energy in the year 2000 will be ___ what it is today.

   A. the same as
   B. two times
   C. three times
   D. ten times

7. Today's energy crisis means ___.

   A. we are running out of energy
   B. we are running out of fossil fuels

8. Which of the following energy sources can we use up?

   A. fossil fuels
   B. solar
   C. wind
   D. hydroelectric

9. Which of the following energy sources has the highest number of deaths related to it's use?

   A. oil
   B. coal
   C. nuclear
   D. hydroelectric

10. The energy source you use to heat your house is ___.

   A. oil
   B. electricity
   C. natural gas
   D. LP gas

INTRODUCTION TO ALTERNATE ENERGY

Discussion:

Propelling automobiles, manufacturing products, turning on lights, and playing video games all require energy. Today, most of our energy comes from oil, coal, and natural gas. Although these sources have been plentiful in the past, our reserves are beginning to dwindle. As a result, scientists and engineers are beginning to develop new sources of energy.

The earth provides humankind with a variety of sources that can be converted into useful forms of energy. These sources include:

* solar energy
* wind energy
* water power
* bioconversion
* ocean thermal energy conversion
* geothermal energy
* nuclear energy
* coal
* petroleum
* natural gas

Solar energy comes to the earth in the form of light from the sun. Solar energy is the most powerful source of energy on earth. If all the sunlight falling on the earth during three days could be concentrated and converted, it would equal all of the earth's known fossil fuel reserves. Solar energy can be used to heat homes, heat water, and produce electricity. Our challenge is to develop more efficient ways to collect, convert, and store solar energy.

Wind energy is actually a form of solar energy. The sun heats the air around the earth unequally. The differences in air temperature cause the air to move in the form of wind currents. Wind energy can be used to drive propellers called turbines. A wind turbine can be used to turn a generator or a pump. When the wind is not available, electrical energy can be stored in batteries.

Water power is the energy in moving water and it can be used to generate electricity. Waves, tides, river currents, ocean currents, and dams can all be sources of energy. Locations where the energy in moving water can be harnessed are very limited. Today, only 13 percent of the electrical energy needed in the United States comes from hydroelectric power plants.

Bioconversion is the process of converting plants and waste materials into usable forms of energy. By heating materials without oxygen, things like manure, garbage, and sewage can be turned into a gas. Other examples of bioconversion include burning firewood for heat, converting corn into ethanol, and using marine plants to make methane gas. Plant and waste sources must be managed carefully to make sure they are not used up before they can be reproduced.

Ocean Thermal Energy Conversion is a safe, possible and clean source of energy for generating electrical power. In certain tropical locations, surface water warmed by the sun can be used to expand a gas. The expanded gas is used to drive turbines that turn a generator. Cold water can be pumped from the depths of the ocean to condense the gas, and the cycle is repeated.

Geothermal energy is heat trapped inside the earth. Nature shows us this heat in the form of hot springs, volcanoes, and geysers. Hot water or steam is produced when underground water comes in contact with rock heated by the earth's interior. In certain areas this heat can be tapped and used to produce electricity. In some cases, geothermal energy can be used to heat homes.

Nuclear energy is the result of splitting a uranium atom and causing other uranium atoms to split in a chain reaction. The energy released during the chain reaction is called fission and it is used to produce steam. The steam drives turbines that turn a generator and produce electricity. A second technique for tapping the energy in an atom is called fusion. Nuclear fusion uses a laser to start the chain reaction and a magnetic field to contain the chain reaction. If the problems can be worked out, nuclear fusion can produce its own fuel. Fear of radiation and the problem of waste have made nuclear energy controversial.

Coal represents 93 percent of the world's and 90 percent of the United State's fossil fuel sources. Coal is called a fossil fuel because it is the product of decayed animals and plants millions of years ago. Dead plants and animals accumulated into a substance called peat. Layers of rock and sediment buried the peat creating pressure and heat. The build up of pressure and heat over millions of years transformed the peat into the rock-like material we call coal. Typically, coal is removed from the earth by means of deep or surface mining, processed, and burned to produce steam in a power plant. However, coal can be converted into a gas or liquid fuel.

Petroleum is a fossil fuel that developed under a dome of rock from the decay of plants and animals millions of years ago. Petroleum deposits are tapped by means of drilling a well. From the well, petroleum must be refined into useful products like gasoline, diesel fuel, and kerosene. In the United States, more than 50 percent of the petroleum products made are used for transportation purposes in the United States. Petroleum is very appropriate for transportation applications because it has a high energy content, it is easy to store, and it is easy to transport. Many experts feel we should save petroleum for applications like transportation where alternative energy sources are not very promising.

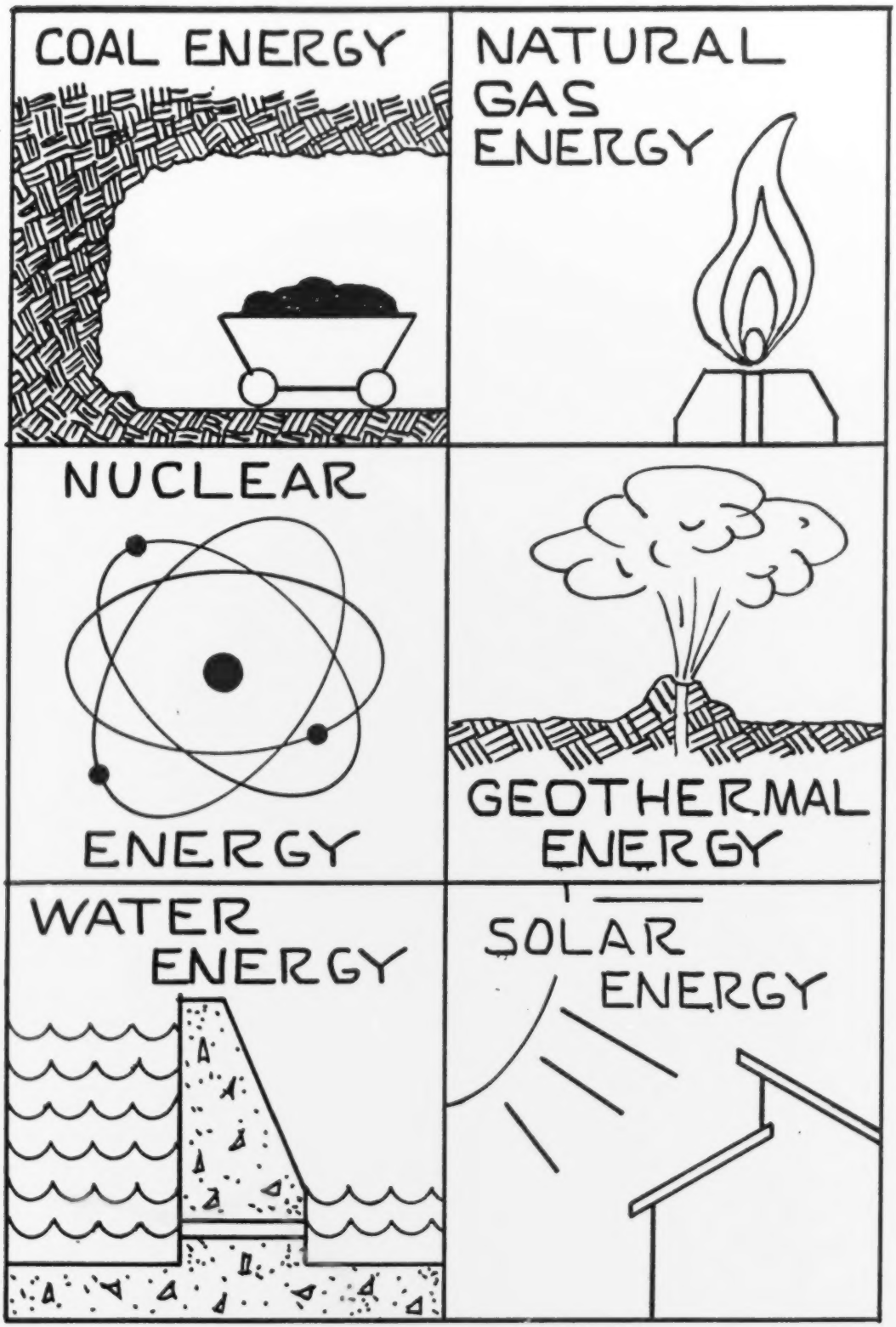
Natural gas, like oil and coal, is the result of decayed animals and plants millions of years ago. Natural gas is most commonly found with oil deposits. Of all the fossil fuels, natural gas is the easiest to process and transport. In addition, natural gas burns the hottest and cleanest. About forty percent of the natural gas used in the United States is used for heating homes and businesses.

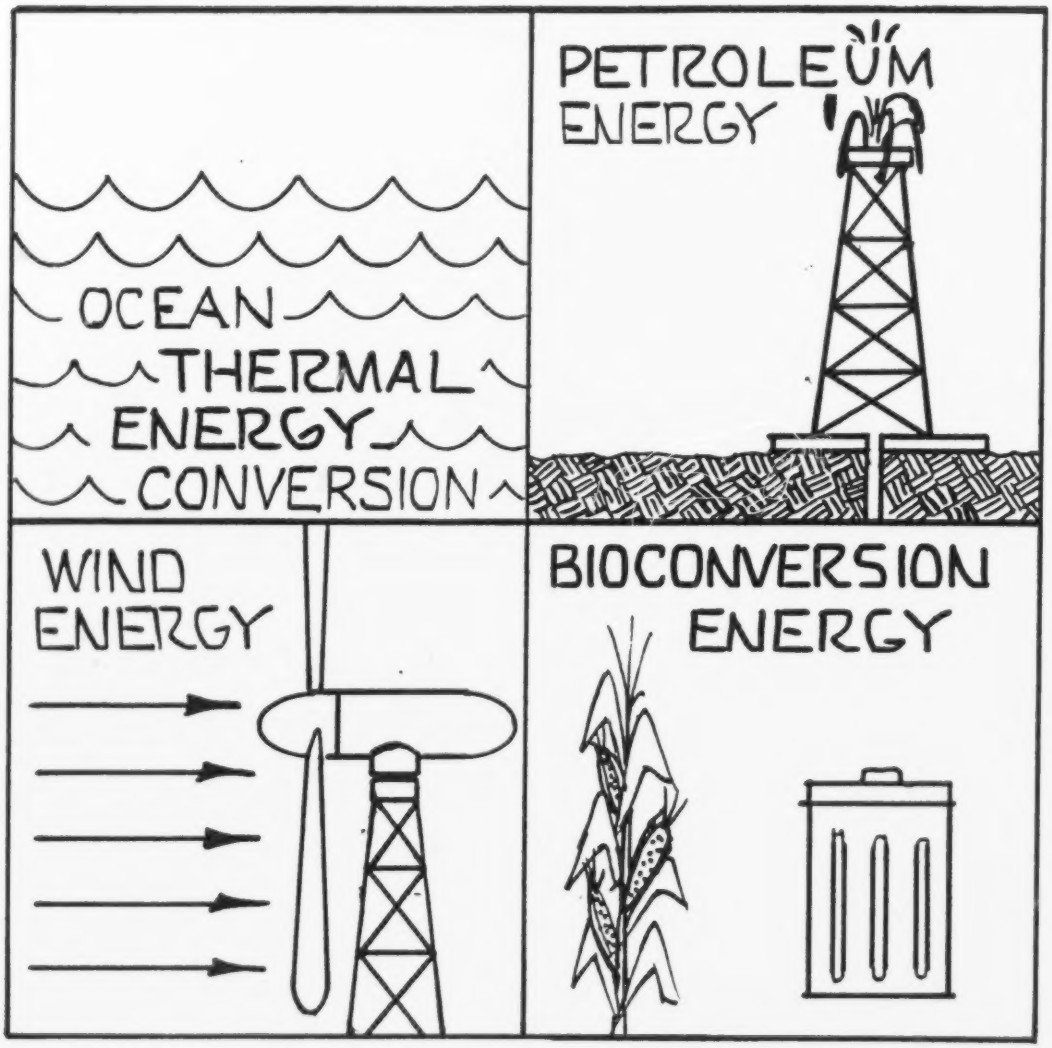
The earth contains a variety of energy sources. The three basic types of sources are nonrenewable, renewable, and inhaustible. The three basic types of fossil fuels are coal, petroleum, and natural gas. Alternative forms of energy include solar, wind, water, bioconversion, OTEC, geothermal, and nuclear energy.

Learning Activities:

All the energy sources available to humankind can be put in one of three categories, nonrenewable, renewable, and inhaustible. Renewable energy sources are in a limited supply and once their usable form has been consumed, they cannot be replaced. Renewable energy sources can be replenished if managed properly. Lastly, inhaustible energy sources cannot be depleted and will always be available. During the following learning activity, you will be identifying the energy sources that fit into each of these categories.

Review the descriptions of the energy sources listed in the "Discussion." Cut out the symbols representing the ten basic types of energy sources. Locate each symbol on either the renewable, nonrenewable, or inhaustible poster. When all your symbols have been located under a category and you have double checked to make sure they are correct, fasten the symbols to their respective poster with tape. When everyone has finished their posters, your teacher will provide the correct category for each energy resource. Correct your posters if needed and keep them for future reference.


COAL ENERGY
NATURAL GAS ENERGY
NUCLEAR ENERGY
GEOTHERMAL ENERGY
WATER ENERGY
SOLAR ENERGY


OCEAN
THERMAL
ENERGY
CONVERSION
PETROLEUM
ENERGY
WIND
ENERGY
BIOCONVERSION
ENERGY

NONRENEWABLE

ENERGY RESOURCES

Unit: Using Alternate Energy Sources — Lesson 2: Wind Energy

Objectives	Lesson Content	Learning Activities	Ref.
A. Following a discussion, students will be able to: -identify the eight basic characteristics of wind energy. -identify the five basic applications for wind energy technology. -identify the seven basic resources required to harness the wind. -describe the difference between lift and drag. -identify the three basic elements required to convert mechanical energy to electrical energy. -distinguish the difference between vertical and horizontal axis wind plants. -identify the basic characteristics of large and small scale wind plants. -complete a flow chart illustrating the wind energy conversion process	A. Wind energy 1. Wind is the result of: a. solar energy b. earth's rotation 2. The basic characteristics of wind energy a. is free b. is clean c. is available 24 hours a day d. cannot be depleted e. can reduce our dependance on fossil fuel energy f. is unpredictable 3. Wind energy applications a. propelling water craft b. grinding grain c. pumping water d. preventing water from freezing e. generating electricity 4. Basic requirements for producing wind energy a. unobstructed site b. average wind of 10 m.p.h. c. money d. turbine e. transducer (generator or pump) f. tower g. storage (battery or water tank)	A. Teacher Guided Discussion 1. Ask students to describe what causes the wind. Explain how wind is the direct result of solar energy and the earth's rotation. 2. Using OT #2-1, discuss the seven basic characteristics of wind energy. 3. Using OT #2-2, discuss the five basic applications for wind energy. 4. Using OT #2-3, discuss the seven basic requirements for harnessing the wind. 5. Using OT #2-4, discuss the three basic elements required to convert mechanical energy to electrical energy. 6. Using OT #2-5, discuss the two basic types of wind plants. 7. Using OT #2-6, discuss the basic characteristics of large scale wind plants. 8. Using Ot #2-7, discuss the basic characteristics of small scale wind plants	

5. Basic elements required to convert mechanical energy to electrical energy
   a. mechanical energy
   b. magnetic field
   c. coiled conductor
6. Basic types of wind plants
   a. horizontal-axis
   b. vertical-axis
7. Large scale wind plants
   a. 5-10 story towers
   b. 100'- 300' turbines
   c. efficient
   d. expensive
   e. requires lots of land
   f. requires high winds
   g. can effect weather, TV signals and migration of birds
8. Small scale wind plants
   a. privately owned
   b. 60' or higher towers
   c. easy to mass produce
   d. operate in low winds
   e. closer to the user
   f. low maintenance
   g. cost between $5,000-$25,000

B. Following demonstrations, in lab activities, students will be able to:
-safely use the tools and materials required to make a wind plant turbine.
-apply the concepts of lift and drag to design a wind plant turbine.
-make a wind plant turbine out of bulsa wood that will rotate in an air current.
-conduct a wind plant experiment according to written and verbal instructions.
-record changes in voltage as wind energy is increased.
-graph the data collected.
-determine the relationship between wind velocity and wind plant energy output.

B. Making and testing wind turbines.
1. Introducing the wind plant project
   a. making turbines
   b. testing turbines
   c. conducting wind plant experiments
2. Characteristics of balsa wood
   a. easy to shape
   b. very light
   c. very soft
3. How to use tools to shape balsa wood
   a. using the vice
   b. using a file
   c. cleaning a file
   d. using sand paper
   e. cleaning sand paper
3. Converting linear mechanical energy to rotary mechanical energy
   a. lift
   b. drag
4. How to make a wind turbine
   a. laying out the material for processing

B. Learning activity
1. Provide students with a broad orientation to the wind energy project and experiment.
2. Discuss the characteristics of balsa wood.
3. Demonstrate how to use the tools required to shape balsa wood into a wind turbine.
4. Demonstrate how to lay the material out for processing, drill a hole in the center of the material, and file and sand the material to shape.
5. Demonstrate how to fasten the turbine to a wind plant, operate a wind source, and test a turbine.
6. Provide each student with a piece of balsa wood for their wind turbine. Have them write an identification number near the center of the material.

b. drilling the center shaft hole with a hand drill
c. shaping the turbine using a file
d. tuning the turbine using sand paper
e. testing the turbine on a wind plant

5. Conducting a wind plant experiment
   a. analyzing the problem
   b. formulating a hypothesis
   c. conducting the experiment
   d. writing a conclusion
6. Conduct the experiment
   a. setting up
   b. reading meters
   c. changing wind velocity
   d. recording data
   e. graphing data
7. Provide each student with HO #2-2 and review the process for making a wind turbine.
8. Have students make and test a wind turbine.
9. When students have finished their wind turbines, distribute HO #2-3.
10. Demonstrate how to conduct a wind plant experiement. During your demonstration, explain how to read the meter, record data, and grab data.
11. When their questions have been answered, have students perform the experiment with their own wind turbines.
12. When students have completed the experiment, discuss the relationship between wind velocity and wind plant energy output.
13. Collect and evaluate your students wind turbines and lab sheets.

WIND ENERGY

Preparation Hints:

1. Review the materials provided, duplicate HO #2-1 through 2-3, and prepare the transparencies needed to present this lesson.

2. During the lab activity, your students will be making and testing wind turbines. Prior to implementing this lesson, you will need to set up several work stations. Each work station will need a wind source (fan), a volt or milliamp meter, two jumper wires, and a wind plant. The fans do not need to be large and a few of your students could bring them from home. The volt meters need to be able to measure less than one volt. If you do not have sensitive volt meters, consider using a milliamp meter. The most important part of the wind plant is a hobby motor. The motors need to use permanent magnets, run on one to three volts DC, and be easy to turn. These motors can often be found at your local electronics and hobby stores. Small motors can also be purchased through many science and industrial arts suppliers. You do not need to buy expensive motors. Motors costing between fifty cents and one dollar will meet your needs.

3. Prior to implementing this lesson, you will need to make wind plants. The most important considerations when making wind plant mockups are holding the motors firmly and not interfering with the air flow. A simple plan for a basic wind plant is provided in Figure 2-1. Depending upon the size and shape of your motors, you may need to modify the design.

4. Prior to implementing this lesson, you will need to prepare materials for your students to make wind turbines. Balsa wood is recommended because it is light and it can easily be shaped with sand paper. It can be purchased at your local hobby store or from many of the popular industrial arts vendors. Unfortunately, balsa wood can be expensive. An alternative material is pine. However, pine will require more time to shape. Cut a piece 3/8" thick (1/4" will work), 1/2" wide, and 10" long for each student in your class. Assign each student a number and have them write it in the center of the material. The center of the material will not need sanded.

Content Presentation Hints:

1. Consider taking your class to the library for one class period. While in the library, your students could collect a variety of design ideas for their wind turbines. While reviewing reference materials, periodicals, and books, your students could also gather information about small scale wind generators, large scale wind generators, and wind farms.

2. Consider showing students a film or video tape on wind energy.

3. When discussing applications for wind energy, ask students to cite examples of wind energy at work in your local community. Their examples might include things like sail boats, wind powered water pumps on farms, and wind generators in rural areas.

4. When discussing basic types and sizes of wind generators, pass around pictures or show slides illustrating various wind plant designs. Discuss the advantages and disadvantages of each design.

Learning Activity Hints:

1. The lab activities are designed to allow the students to experience the wind energy conversion process. The first part of the wind energy conversion process is to convert the wind's linear mechanical energy into rotary mechanical energy. To enable students to experience the concepts of lift and drag, have each student take out a piece of paper and hold it in front of their mouth as illustrated in the handout. Instruct students to blow air across the top of the paper. If done correctly, the students should be able to cause the paper to rise.

   To demonstrate drag, have each student hold their paper with one hand in front of their face as if they were going to read tiny type. Instruct students to blow air against the middle of the paper. Students should be able to feel the paper begin to turn around in their hand.

2. The second part of the wind energy conversion process is to convert the rotary mechanical energy into electrical energy. For the purpose of this activity, students need only learn the three basic elements required to convert mechanical energy into electrical energy (a magnetic field, a coil of wire, and motion). To accom-

plish this goal, you need a 6 volt battery, a volt meter, wire, and a speaker. Extend two wire leads from the speaker (see Figure 2-2).

By touching the leads to the battery, demonstrate that voltage applied to the speaker results in motion and sound. Do not allow the leads to stay in contact with the battery terminals for more than a second. Explain how electricity flowing through a coil results in a magnetic field. The magnetic field produced by the coil opposes the magnetic field produced by the magnet and motion is the result. Ask your students if electricity fed into the speaker produces motion, will applying motion to the speaker produce electricity. Make sure the leads are apart and away from the battery. Connect the speaker wire to a volt meter (see Figure 2-3). Apply light pressure to the speaker cone and have students watch the volt meter. With each push of the speaker cone, the needle on the volt meter should swing. If the meter does not move, try switching the leads on the meter, or apply pressure under the cone to push it up instead of down.

Lastly, show students that the same concepts apply to motors/generators. Connect a battery to a motor and motin is the output. Connect a volt meter to the motor, turn the motor quickly and electricity is the output.

3. Students need to understand the tools and materials they will be using to make the turbines. Show students that balsa wood is lightweight, easy to shape, and very soft. Caution students on how easy it is to file or sand balsa too much. Demonstrate how to properly use files and various grades of sandpaper. To minimize waste, show students how to clean files and sandpaper. Allow several of the students to try shaping balsa using the tools and techniques demonstrated.

4. When demonstrating how to make a wind turbine, emphasize the importance of maintaining an airfoil shape, making sure the blades on each side of center are tapered in opposite directions, and making sure the turbine blade is balanced.

5. Students need to experience the two basic conversion processes together and experience the relationship between input wind energy and output electrical energy. Since the amount of wind energy available is always changing, it is important that students experience the relationship between the wind's velocity and output energy from a windplant. At each work station, lay out a series of fan positions using masking tape. These

positions should range from about six inches to several feet away from the wind plant. It is important that most of your student's turbines operate to some degree when the fan is located in most of the positions. Label each position with a number starting with the position furthest away from the windplant. Connect a volt meter to each windplant.

Review the lab sheet with students and perform one dry run of the experiment. Each student should start with the fan in the position furthest from the windplant. Students can try to help the turbine get started if it does not want to turn. If their turbine does not turn they should record a zero for position number one and move the fan to the next position. If the turbine does begin to turn they should read and record the meter reading and proceed to the next position. Students should be reading and recording higher voltages as the fan moves closer to the windplant. Have students complete the lab sheet and turn it in. If time remains in the class period, have students report their findings and experiences.

6. When students have finished the wind plant experiment, consider making a wind farm. This lab activity will require all the windplants and the fans and will be performed by the class as a whole. Locate all the windplants on one table or bench. Locate one fan in front of each windplant. Explain how the work bench represents a wind farm site. Assign students to the individual fans and windplants. Have other students read the meters, record the data, and determine power output. Begin the experiment by wiring the windplants in series (see Figure 2-4). Use a light bulb or LED for the load. Connect a milliamp meter in series with the load, and connect the volt meter in parallel with the bulb.

   Have students turn on the fans, let the windplants reach full speed, read the meters, record the data, and determine the power output. Disconnect a wire from one of the windplants and have students observe the light bulb for the result. Ask students if they would want their town served by a wind farm wired in series.

   Wire the windplants in parallel (see Figure 2-5). Have students turn on the fans, read the meters, record the data, and determine the power output. Disconnect a wire from one of the wind plants and have students observe the light bulb for the result. Hopefully, you should still have enough voltage for it to stay on. Explain to student the differences between the two circuits. Compare the output readings and the power output from each circuit.

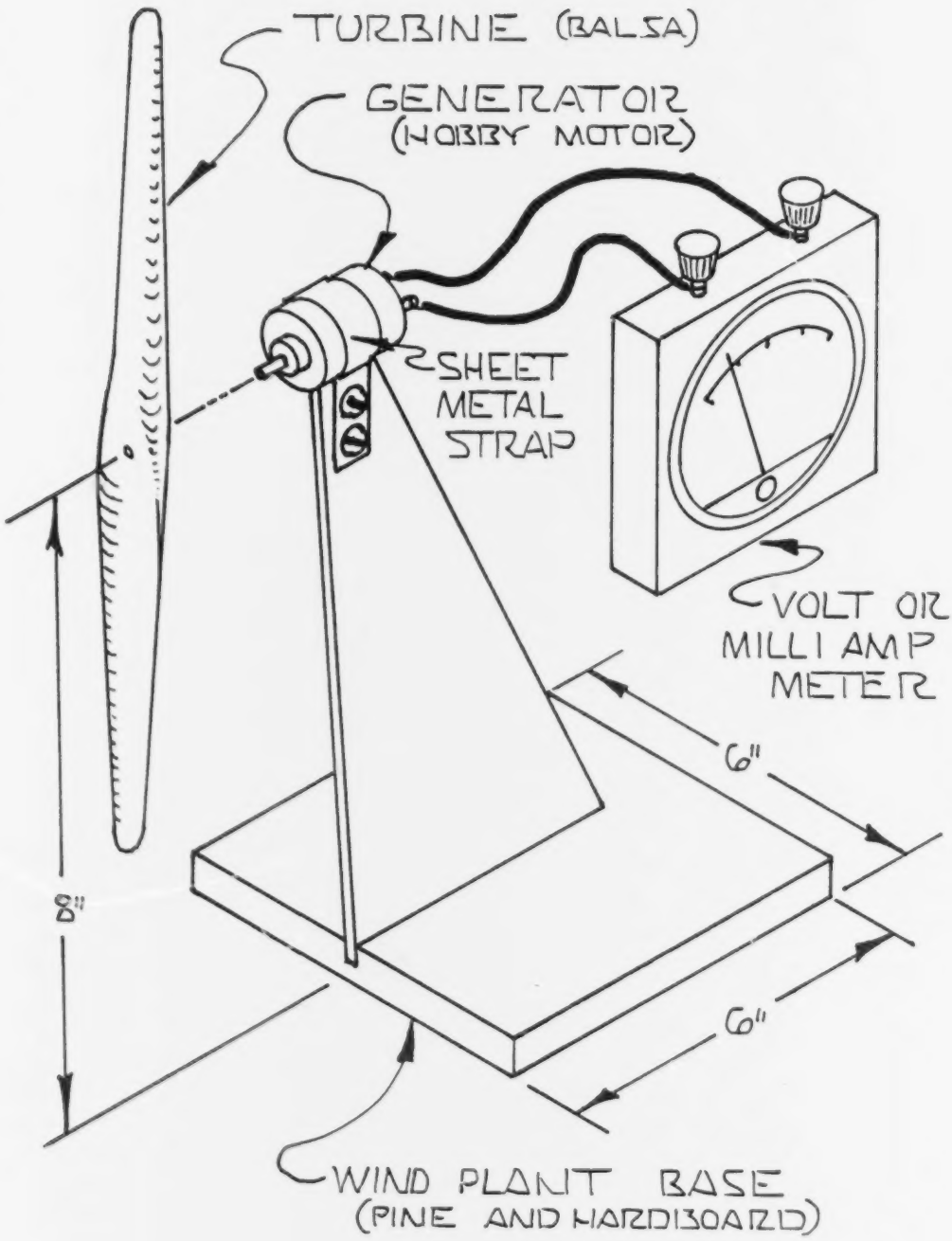


FIGURE 2-1, BASIC WIND PLANT

FIGURE 2-2
AND 2-3

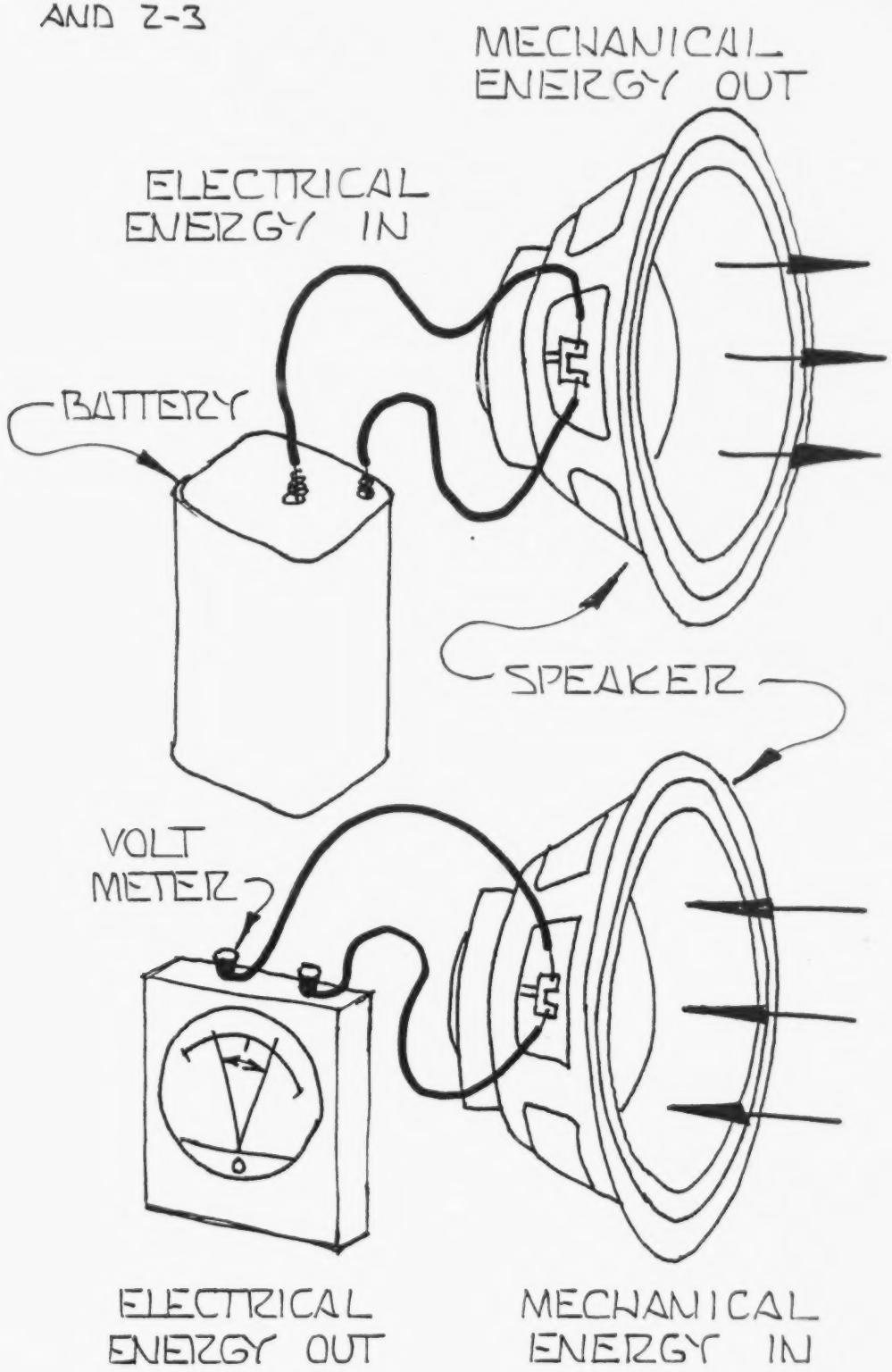
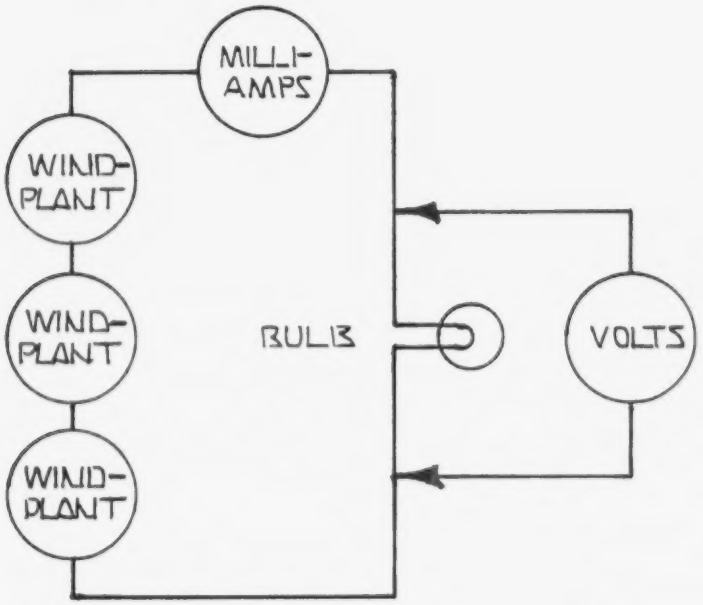
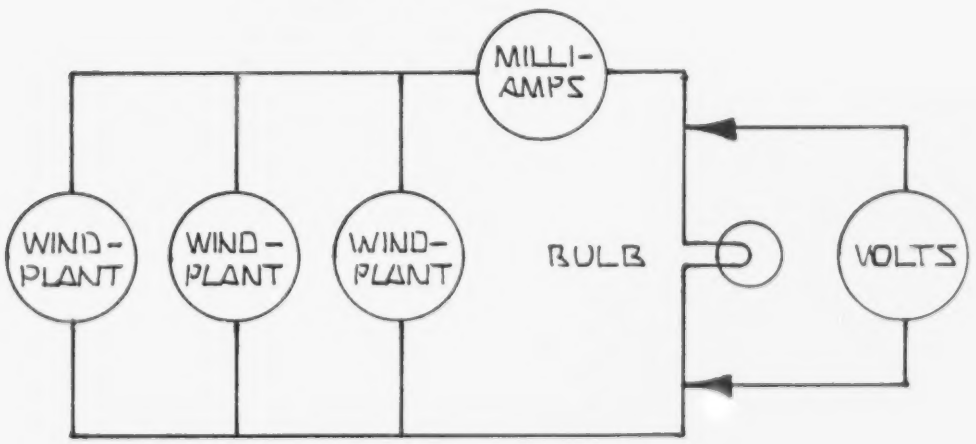


FIGURE 2-4



WINDPLANTS WIRED IN SERIES

FIGURE 2-5



WINDPLANTS WIRED IN PARALLEL

OT #2-1

BASIC CHARACTERISTICS OF WIND ENERGY:

* free
* clean
* available 24 hours a day
* cannot be depleted
* can reduce our dependance on fossil fuel energy
* unpredictable

OT #2-2

WIND ENERGY APPLICATIONS:

* propelling water craft
* grinding grain
* pumping water
* preventing water from freezing
* generating electricity

OT #2-3

BASIC REQUIREMENTS FOR PRODUCING WIND ENERGY:

* unobstructed site
* average wind of 10 m.p.h.
* money
* turbine
* transducer (generator or pump)
* tower
* storage (battery or water tank)

OT #2-4

BASIC ELEMENTS REQUIRED TO CONVERT MECHANICAL ENERGY TO ELECTRICAL ENERGY:

* mechanical energy
* magnetic field
* coiled conductor

OT #2-5

BASIC TYPES OF WIND PLANTS:

* horizontal-axis
* vertical-axis

OT #2-6

LARGE SCALE WIND PLANTS:

* 5-10 story towers
* 100' - 300' turbines
* efficient
* expensive
* requires lots of land
* requires high winds
* can effect weather, TV signals, and migration of birds

OT #2-7

SMALL SCALE WIND PLANTS:

* privately owned
* 60' or higher towers
* easy to mass produce
* operate in low winds
* closer to the user
* low maintenance
* cost between $5,000 - $25,000

WIND ENERGY

The sun heats the earth's surface unequally. The differences in temperature from one place to another as the earth rotates causes the movement of air we call wind. Wind energy is the result of solar energy. Wind energy is free, it does not pollute, and it is available 24 hours a day. Unfortunately, the amount of wind energy available changes and these changes are difficult to predict.

Using the wind as an energy source is an old idea. Windmills for pumping water used to be a common sight on American farms. When electrical power became widely available and cheap, most water pumping windmills were taken out of service. There is a renewed interest in the wind as a source of energy due to the rising cost of electricity. The machines that convert the wind's energy into electrical energy are often called windplants. Wind energy could provide 7 to 19 percent of all the electricity used in the United States. Producing more electricity by means of wind energy will help to save fossil fuels. It is important that we conserve fossil fuels for energy problems that only fossil fuels can solve.

To take advantage of the wind's energy, one needs a site. The site is an area of land that does not have things like trees, hills or buildings blocking the wind. The site must also have at least an average wind of about 10 miles per hour to be useful. Many experts feel a year should be spent studying the wind at a site before the windplant can be built.

Another requirement for using wind energy is money. The wind itself may be free, but the technology needed to convert the energy can be very expensive. A windplant for your home can cost between 5,000 and 25,000 dollars. A large scale windplant for a community can cost three to four times what a coal-burning power plant costs.

Today, most of the windplants are used to generate electricity. In order to generate electricity the wind flowing across the site must be converted into a rotary motion. This conversion is done with a set of blades called a turbine. The wind causes the turbine to run through the principles of lift and drag.

The pushing force the wind has on a flat or cupped surface is called drag. You have experienced drag when you put your hand outside a car window while moving down the highway. Your hand wanted to move backward due to drag.

The Savonius windmill, which dates back to the 10th Century, uses the drag principle to turn the blades (see Figure 2-7). The flow of air around an airfoil shaped blade produces an aerodynamic action called lift (see Figure 2-6). The movement of air across the top of the blade causes a low pressure area. This low pressure area is due to the air on top of the blade moving much faster than the air under the blade. The higher pressure under the blade causes an upward force. You can experience lift by cupping a piece of paper in front of your mouth and blowing over the top of it (see Figure 2-8). The paper should rise. You can experience drag by blowing air into the center of a piece of paper while holding it in front of your face (see Figure 2-9). The paper moves backwards.

The two basic types of windplants are horizontal-axis and vertical-axis. Horizontal-axis windplants use a turbine that rotates on a horizontal shaft (see Figure 2-10). Vertical axis windplants use a turbine that rotates on a vertical shaft (see Figure 2-11).

Windplants can also be designed on a large scale or a small scale. For the most part, engineers and scientists have given most of their attention to large scale windplants. However, many experts now feel small scale windplants have more promise as an alternative energy system.

Large scale windplants use towers between five and ten stories high. The turbines have blades that range between 100 and 300 feet from tip to tip. NASA and the Department of Energy built a windplant in Boone, North Carolina that has a blade diameter of 220 feet. Large scale windplants are more efficient than small scale wind plants. A large scale windplant with a blade diameter of 100 feet can convert four times the energy a windplant with a blade 50 feet in diameter can convert.

There are some problems with the large scale windplants. Many experts feel that large scale windplants could interfere with TV signals, effect the weather, and alter the migratory patterns of birds. For safety reasons, large scale windplants require large amounts of land. Lastly, the electrical energy from large scale windplants can cost up to 10 times what electrical energy costs from fossil fuel or nuclear power plants.

Privately owned small scale windplants are more practical. They are easier to mass produce, they are less likely to be damaged by the wind, and they require less maintenance. Due to their small size, small scale

windplants operate a greater percentage of the time. In addition, small scale windplants can be located closer to the energy user, thus reducing the cost of distribution.

Small scale windplants have some disadvantages too. If small scale windplants become popular, they could create the same visual pollution that oil rigs do in many parts of the country. Lots of independently owned windplants could reduce the role of large power companies. Large power companies may have to increase the price of energy due to reduced demand. In addition, owners of windplants may have to pay higher rates because they use much less energy.

The amount of wind energy available for conversion varies. On a windy day, there may be more energy available than one can use. On calm days there might not be enough energy available to meet one's basic needs. There is a need to store excess energy produced on windy days for use on calm days. On windy days and at night, electrical energy is often stored in a series of batteries. On a calm day, the batteries are used to provide electrical energy. The storage batteries will not be able to provide enough energy if you have a lot of calm days in a row. Storage batteries are very expensive. Another solution is to buy energy from the utility company on calm days. On windy days, the utility company is required by law to buy your excess energy produced by your windplant.

Wind energy is free, it does not pollute, and it is available 24 hours a day. The basic sources needed to harness the wind are an unobstructed site, and average wind speed of about 10 miles an hour, money, a wind turbine, a transducer, a storage system, and a tower. Harnessing the wind involves converting the linear mechanical energy of the wind into rotary mechanical energy using the concepts of lift and drag. In addition, the rotary mechanical energy often needs to be converted to electrical energy using a generator. The two basic types of wind plants are horizontal-axis and vertical-axis. They can be built on a large or small scale.

Learning Activities:

With the cost of fossil fuels increasing, there has been a renewed interest in using the wind to generate electricity. The first part of the wind energy conversion process is to convert the wind's linear mechanical energy to rotary mechanical energy. The second part of the process is to convert the rotary mechanical energy to electrical energy. During the following learning activities, you will apply the concepts of lift and drag to make a wind turbine.

After testing your turbine, you will conduct a wind plant experiment to investigate the relationship between input wind energy and output electrical energy.

Making a Wind Turbine:

1. Locate and mark the center of your material on one of the 1/2" wide surfaces as illustrated.

2. Using a compass or circle template, draw a half inch circle around the center point. Do not sand or file the material inside the half inch circle.

3. Drill a hole through the center of your material smaller than the input shaft on your wind generator. After you finish drilling the hole, you should be able to fasten your material to the generator with a friction fit. Since the hole is very small, you may need to use a small nail for a drill bit.

4. Using a straight edge and a pencil, lay out the taper for the blades as illustrated.

5. File the trailing edges of the material to the taper lines.

6. Using a file, taper the blades as illustrated. Make sure you taper the blades in opposite directions.

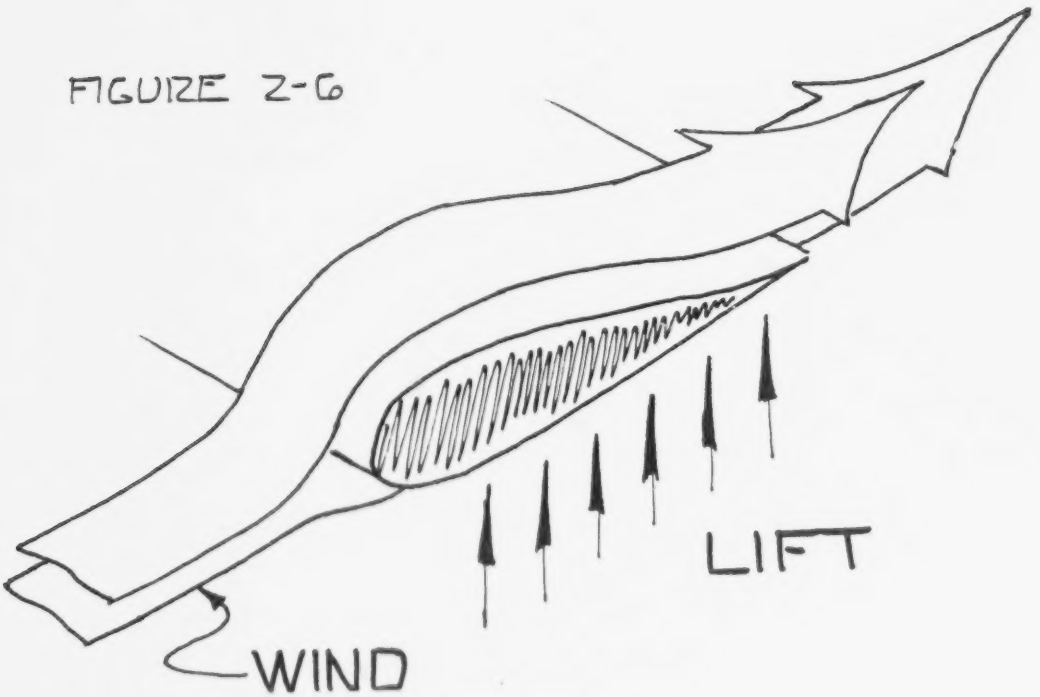
7. Using sand paper, round the leading edges of the blades into an airfoil-like shape.

8. When you have finished your turbine, fasten it to a wind plant, position a household fan about three feet away, and turn it on. Your wind turbine should begin to turn. If it doesn't turn right away, give it a little help. Make additional modifications if needed.

Conducting the Wind Plant Experiment:

Review the wind plant experiment lab sheet. Read the problem carefully, complete the hypothesis section, and set up the experiment as illustrated in Figure 2-12. Follow the procedures provided, and report your findings. When you have finished, clean up the lab station according to your teachers instructions.

FIGURE 2-6



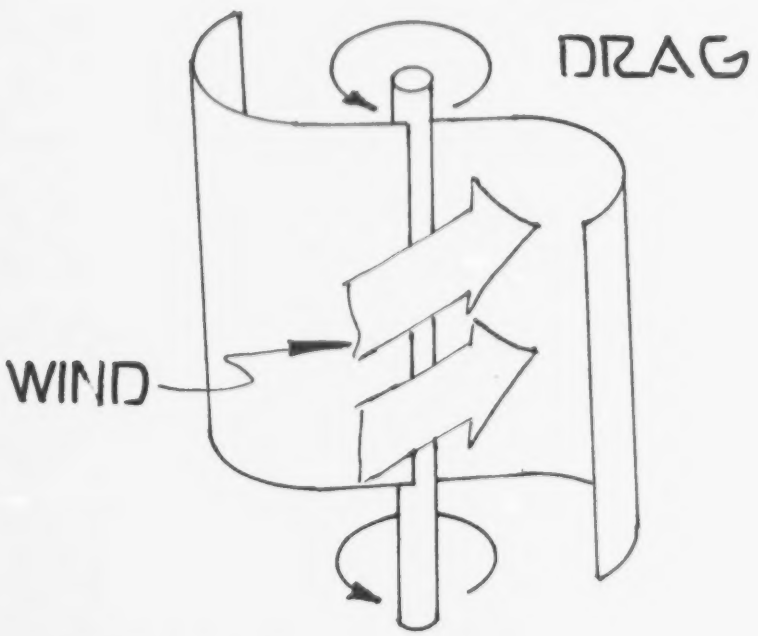
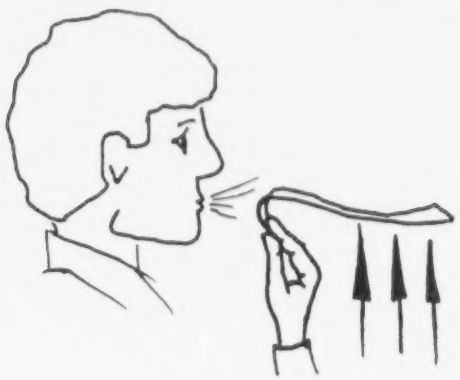


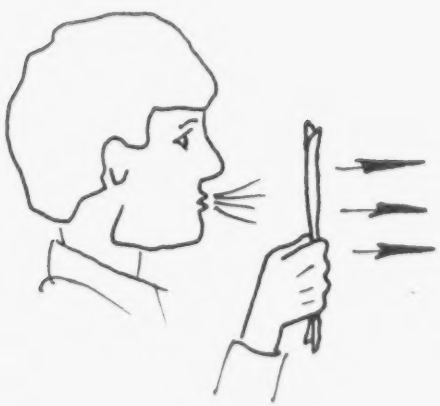
FIGURE 2-7

FIGURE 2-8



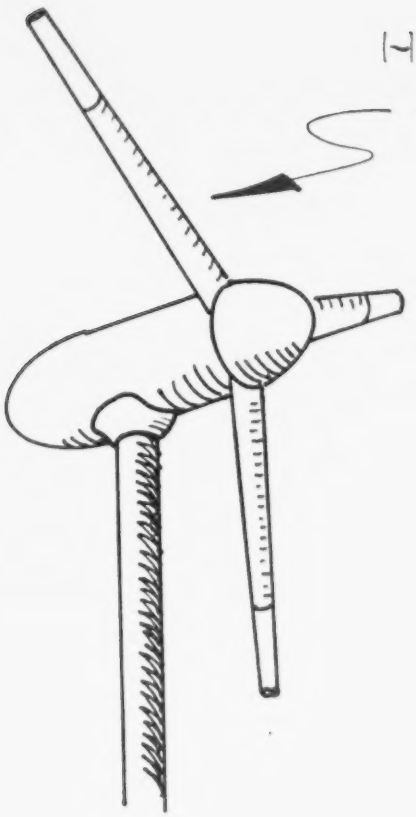
LIFT

FIGURE 2-9



DRAG

FIGURE 2-10



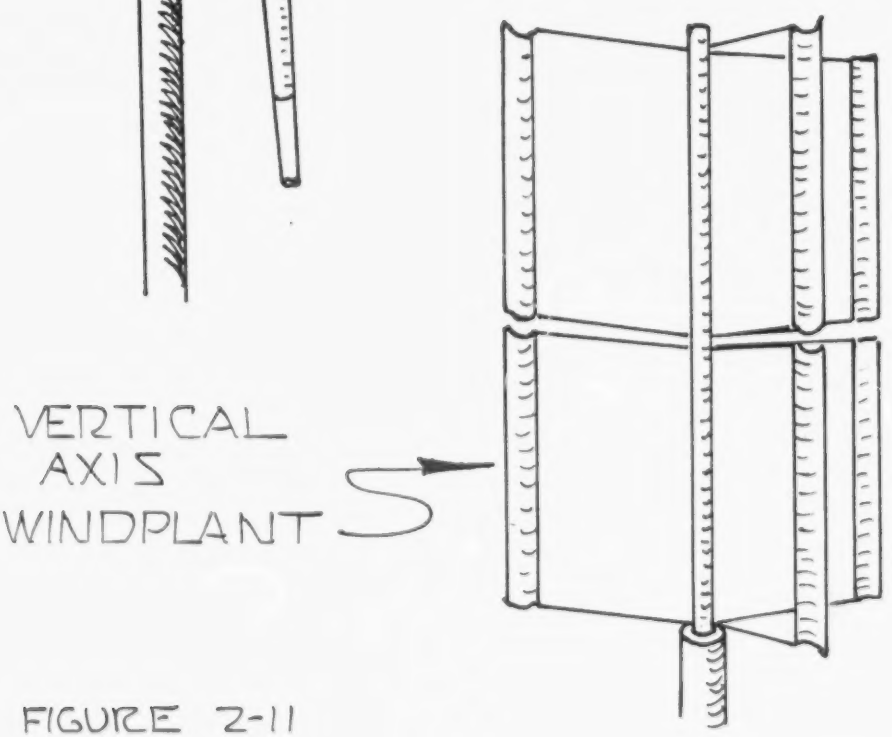
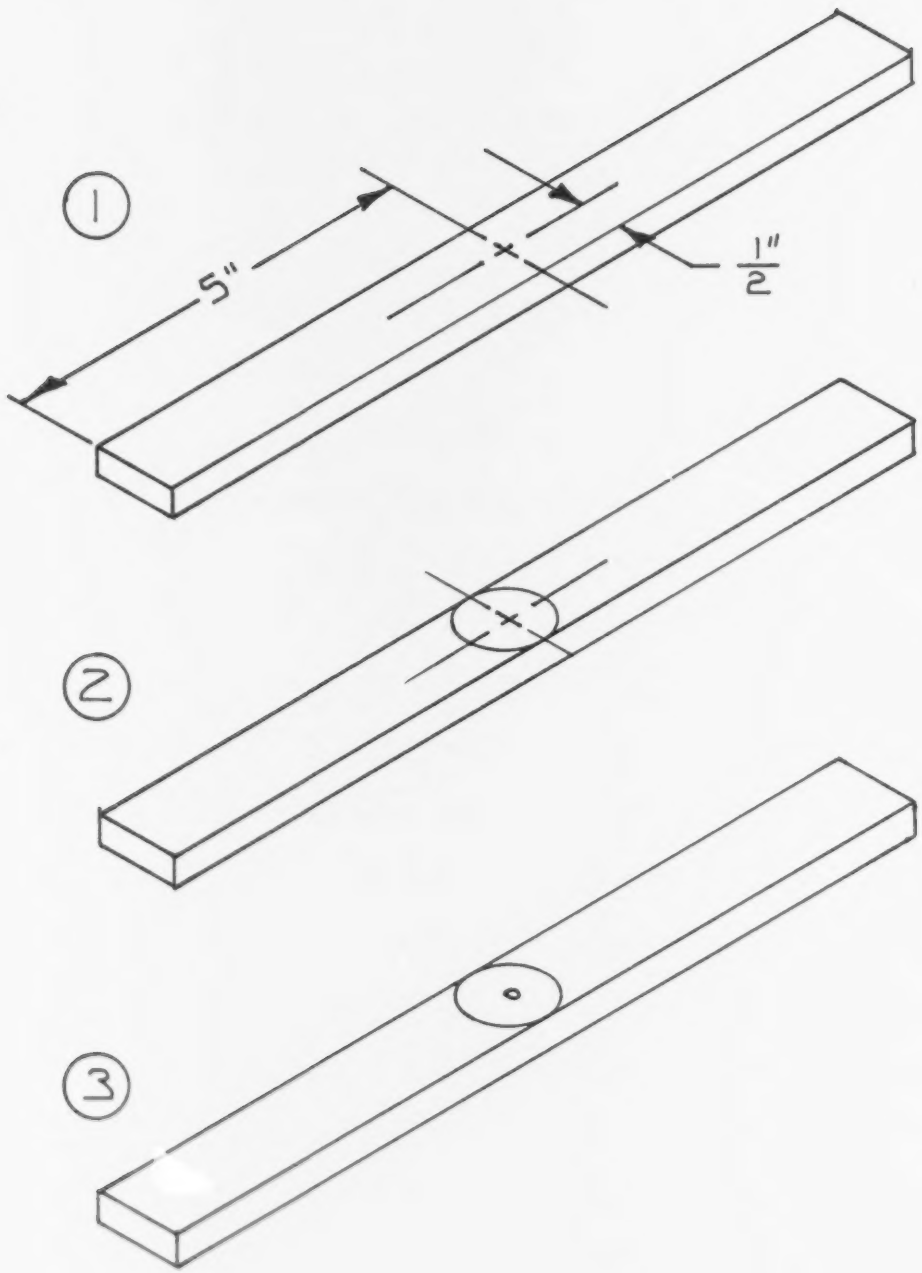


FIGURE 2-11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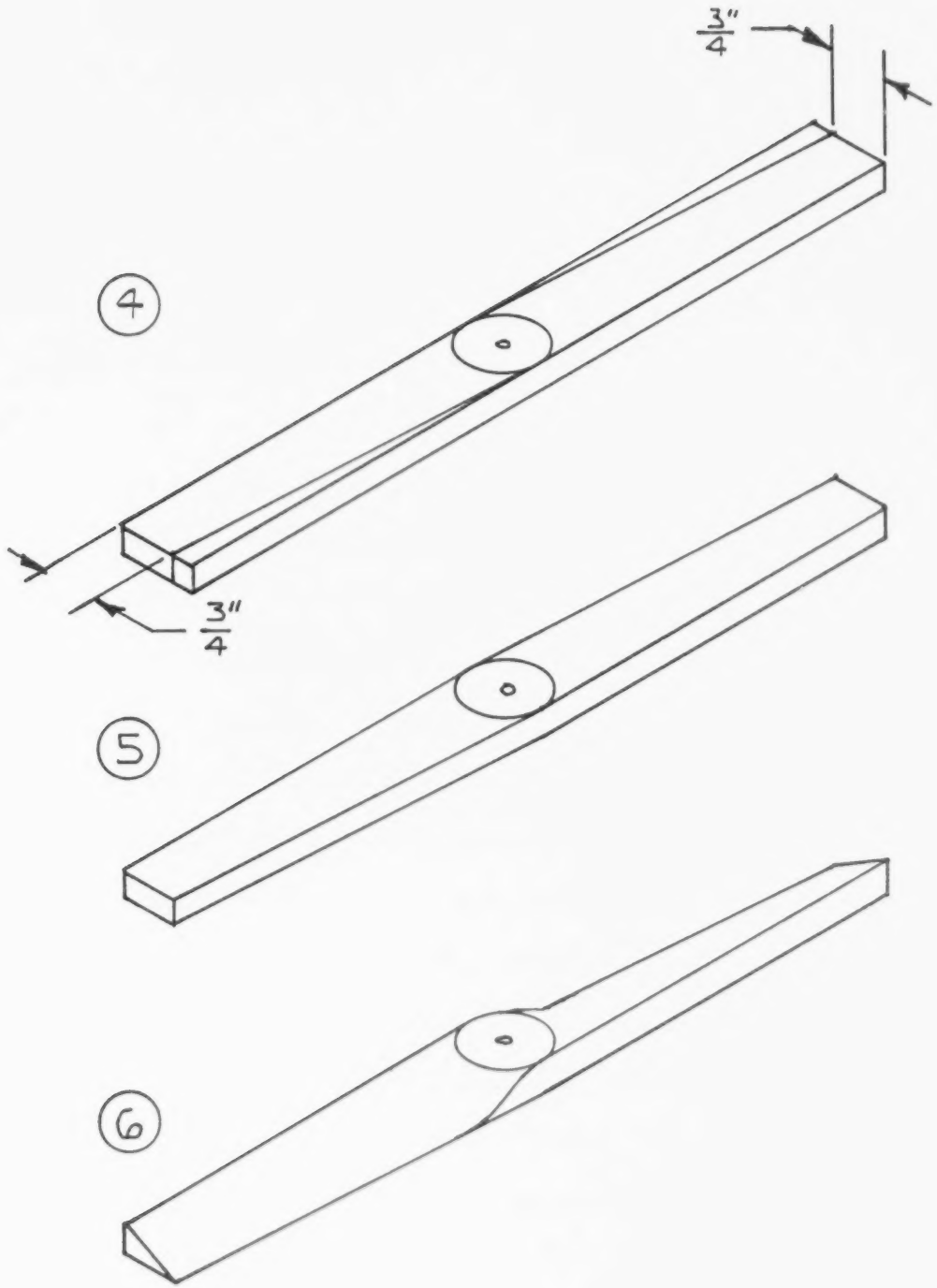
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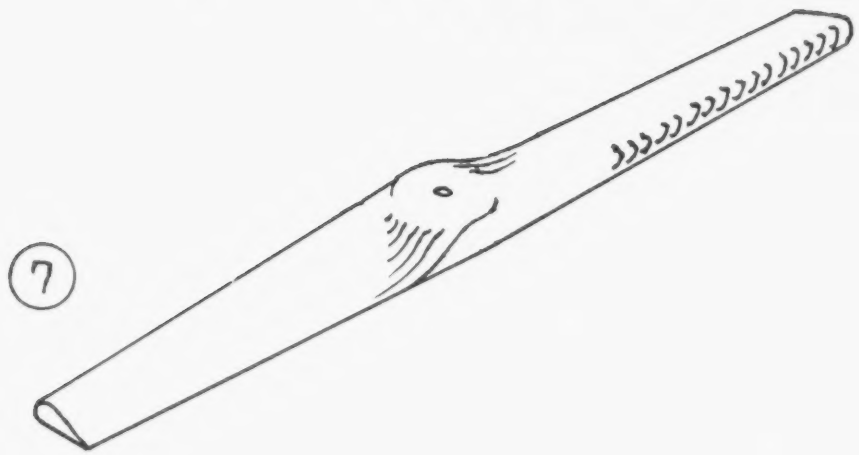
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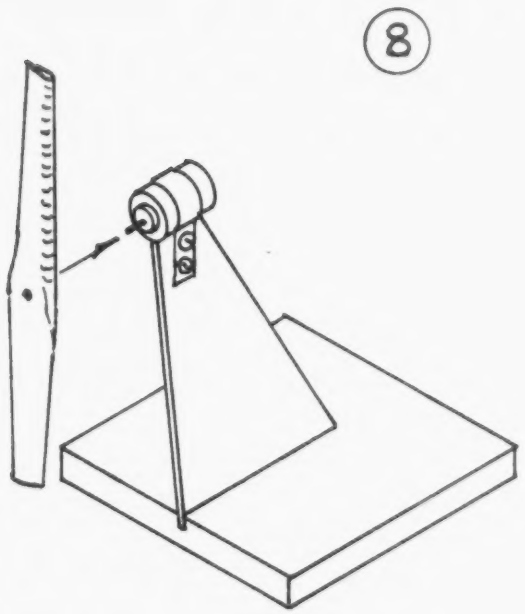

8

WIND PLANT EXPERIMENT LAB SHEET

The Problem:

How does wind speed effect the energy output from a windplant?

Hypothesis:

An increase in wind speed will _____.

A. cause a decrease in energy output
B. cause an increase in energy output
C. not effect the energy output

Experiment Procedure:

1. Fasten your wind plant to a table using a C clamp. Connect a volt or milliamp meter to the wind plant. Using jumper leads, connect the positive terminal on the wind plant to the positive terminal on the meter. Connect the negative terminal on the wind plant to the negative terminal on the meter. Lay out a strip of masking tape from the front of the wind plant to a position about six feet away. Measure one foot along the tape from the wind plant. Call this Test Point 6. Measure along the tape one foot from Test Point 6. Call this new point Test Point 5. Continue counting down test points until you have identified Test Point 1. Position your fan at Test Point 1 and turn it on.

2. Is your turbine turning _____(Yes/no)? If your answer is yes, read the meter and record the current or voltage in the space provided.

   _____

3. Move the fan to test point number two. Is your turbine turning _____(Yes/no)? If your answer is yes, read your meter and record the voltage or current in the space provided below.

   _____

4. Move the fan to test point number three. Is your turbine turning _____(Yes/no)? If your answer is yes, read your meter and record the voltage or current in the space provided below.

_____

5. Move the fan to test point number four. Is your turbine turning _____(Yes/no)? If your answer is yes, read your meter and record the voltage or current in the space provided below.

_____

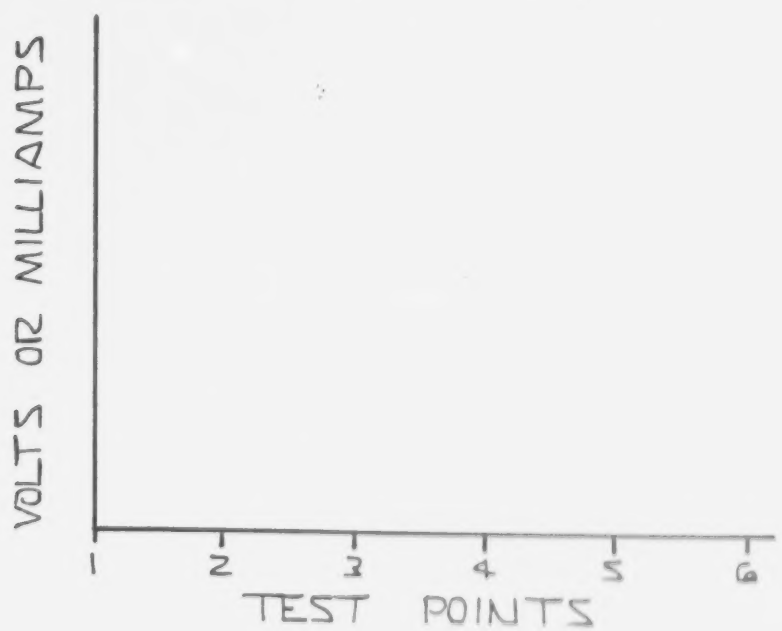
6. Move the fan to test point number five. Is your turbine turning _____(Yes/no)? If your answer is yes, read your meter and record the voltage or current in the space provided below.

_____

7. Move the fan to test point number six. Is your turbine turning _____(Yes/no)? If your answer is yes, read your meter and record the voltage or current in the space provided below.

_____

8. Plot your meter readings on the graph below.



CONCLUSION:

1. As wind speed increases, energy output from the wind plant _____.

   A. increases
   B. decreases
   C. stays the same

2. Complete the flow chart by matching the wind energy element (list at the top) with their proper location in the wind energy conversion process.

   A. The generator converts mechanical energy to electrical energy

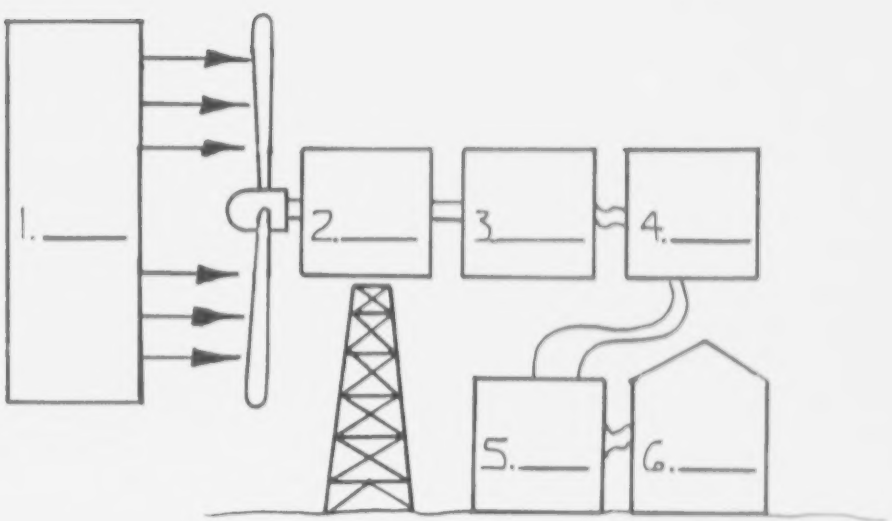
   B. The consumer utilizes the energy to perform work.

   C. Mechanical energy in the wind is used to turn a turbine.

   D. The mechanical energy from the turbine is used to turn a generator.

   E. Solar energy heats the atmosphere unevenly which produces wind current.

   F. Surplus electrical energy is stored in batteries or purchased by the utility company.



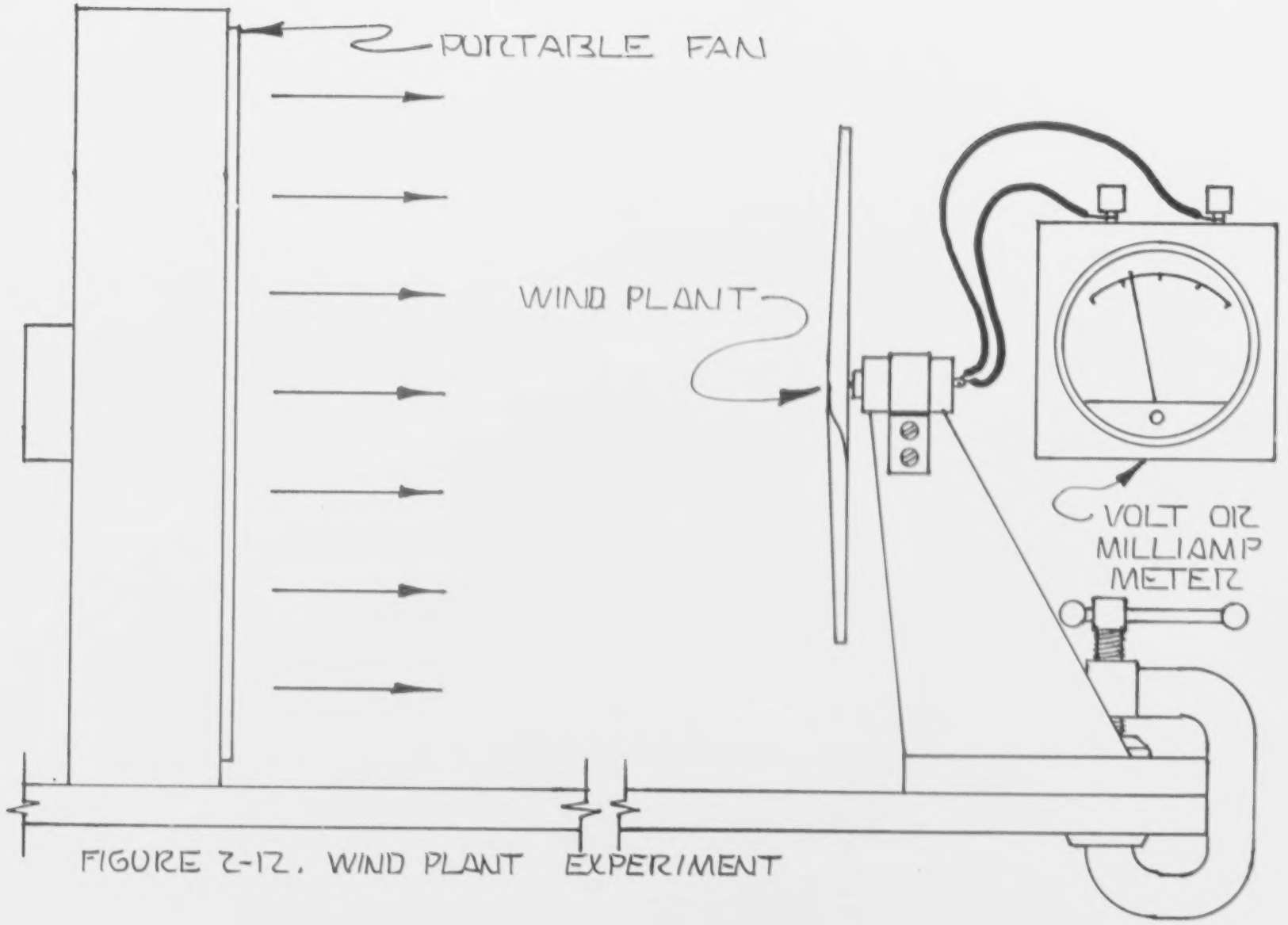


FIGURE 2-12. WIND PLANT EXPERIMENT

Unit: Using Alternate Energy Sources

Lesson 3: Ocean Thermal Energy Conversion

Objectives	Lesson Content	Learning Activities	Ref.
A. Following a discussion, students will be able to: -identify the five basic requirements for OTEC -identify the six basic steps in the OTEC process. -identify the four problems associated with OTEC.	A. Ocean Thermal Energy Conversion 1. Requirements a. solar energy b. 80 degree surface water c. 40 degree deep water d. OTEC power plant e. lots of money 2. Energy conversion process a. solar energy heats surface water b. warm surface water is used to expand a gas c. the expanded gas is used to turn a turbine. d. the turbine turns a generator e. cool water is pumped from deep in the ocean. f. the cool water condenses the gas. g. the cycle repeats. 3. Problems a. very few good sites b. very expensive c. electrical energy must be transmitted long distance to shore d. sea water corrosion and storm damage	A. Teacher Guided Discussion 1. Introduce students to the concept of ocean thermal energy conversion. Explain how solar energy heats tropical ocean water to temperatures of about 80 degrees Fahrenheit, while water about 1,000 feet remains about 40 degrees Fahrenheit. Tell students that this difference in temperature can be used to generate electricity. 2. Using OT #3-1, discuss the five basic requirements needed for ocean thermal energy conversion. 3. Using OT #3-2, explain the ocean thermal energy conversion process. 4. Using OT #3-3, discuss the four basic problems of ocean thermal energy conversion.	

B. Following an OTEC demonstration, students will be able to correctly complete a flow chart illustrating the ocean thermal energy conversion process.	B. OTEC Demonstration 1. Define the role of the materials 2. Expand air in a balloon 3. Condense air in a balloon 4. Define where the energy can be tapped 5. Complete flow chart	B. Teacher Demonstration 1. Obtain and prepare the required demonstration materials before class. 2. Explain the roles being played by demonstrating the material. 3. Expand the air in a balloon by placing a bottle/balloon assembly into hot water. 4. Condense the air in a balloon by placing a bottle/balloon assembly in cold water. 5. Ask students to identify a location in the bottle/balloon assembly where energy could be tapped. 6. Explain how the demonstration elements apply to the ocean thermal energy conversion process. 7. Provide students with HO #3-1, have them read the content abstract, and ask them to complete the flow chart. 8. When students have finished, collect and evaluate the flow charts.

OT #3-1

REQUIREMENTS FOR OTEC:

* solar energy
* 80 degree surface water
* 40 degree deep water
* OTEC powerr plant
* lots of money

OT #3-2

OCEAN THERMAL ENERGY CONVERSION PROCESS:

* solar energy heats surface water
* warm surface water is used to expand a gas
* the expanded gas is used to turn a turbine
* the turbine turns a generator
* cool water is pumped from deep in the ocean
* the cool water condenses the gas
* the cycle repeats

OT #3-3

PROBLEMS WITH OCEAN THERMAL ENERGY CONVERSION:

* very few good sites
* very expensive
* electrical energy must be transmitted long distance to shore
* sea water corrosion and storm damage

OCEAN THERMAL ENERGY CONVERSION

Preparation Hints:

1. Review the materials provided, duplicate HO #3-1, and prepare the transparencies needed to present this lesson.

2. During the laboratory component, you will be conducting a simple demonstration before your class. Prior to implementing this lesson, you will need to collect and prepare a variety of materials.

3. Obtain a plastic bottle and a balloon. The plastic bottle should be able to hold about one liter. The balloon should be easy to blow up. If the balloon is stiff, blow it up and leave it expanded for a few days before the demonstration. Before the demonstration, put both the balloon and the bottle in a refrigerator for about an hour. Do not remove the bottle and balloon until just prior to the demonstration.

4. You will need two large containers for the demonstration. Each container should be able to hold several gallons of water. Just before class, fill one container with hot water. Fill the other container with cold water and ice cubes. Retrieve your bottle and balloon. Squeeze all the air from the balloon and install the neck of the balloon over the mouth of the bottle. Locate the demonstration materials so your whole class will be able to see them. You are now ready to go.

Content Presentation Hints:

1. After introducing students to the OTEC concept and requirements, conduct the OTEC demonstration (refer to Figure 3-1). Use the demonstration to introduce the ocean thermal energy conversion process.

Learning Activity Hints:

1. Ask one of your students to identify which of the demonstration materials represent solar heated ocean water. Ask another student which of the demonstration materials represent cold water pumped up from deep in the ocean. Lastly, ask a student to locate the gas that will be expanded.

2. Have a student place the bottle/balloon assembly in the container of hot water. The balloon should inflate to some degree. Ask students to explain why the balloon inflated. Ask your students what would happen if the bottle/balloon assembly were placed in the cold water. Have the student transfer the bottle/balloon assembly to the container of cold water. The balloon should deflate. Repeat the process several times using various students. While students are repeating the process, ask the class where in the system would they place a small turbine and generator to produce electricity. Hopefully, one of the students will say in the mouth of the bottle.

3. Use the demonstration materials and the students responses to explain the Ocean Thermal Energy Conversion process. When all questions have been answered, have students complete the OTEC flow chart (HO #3-1).

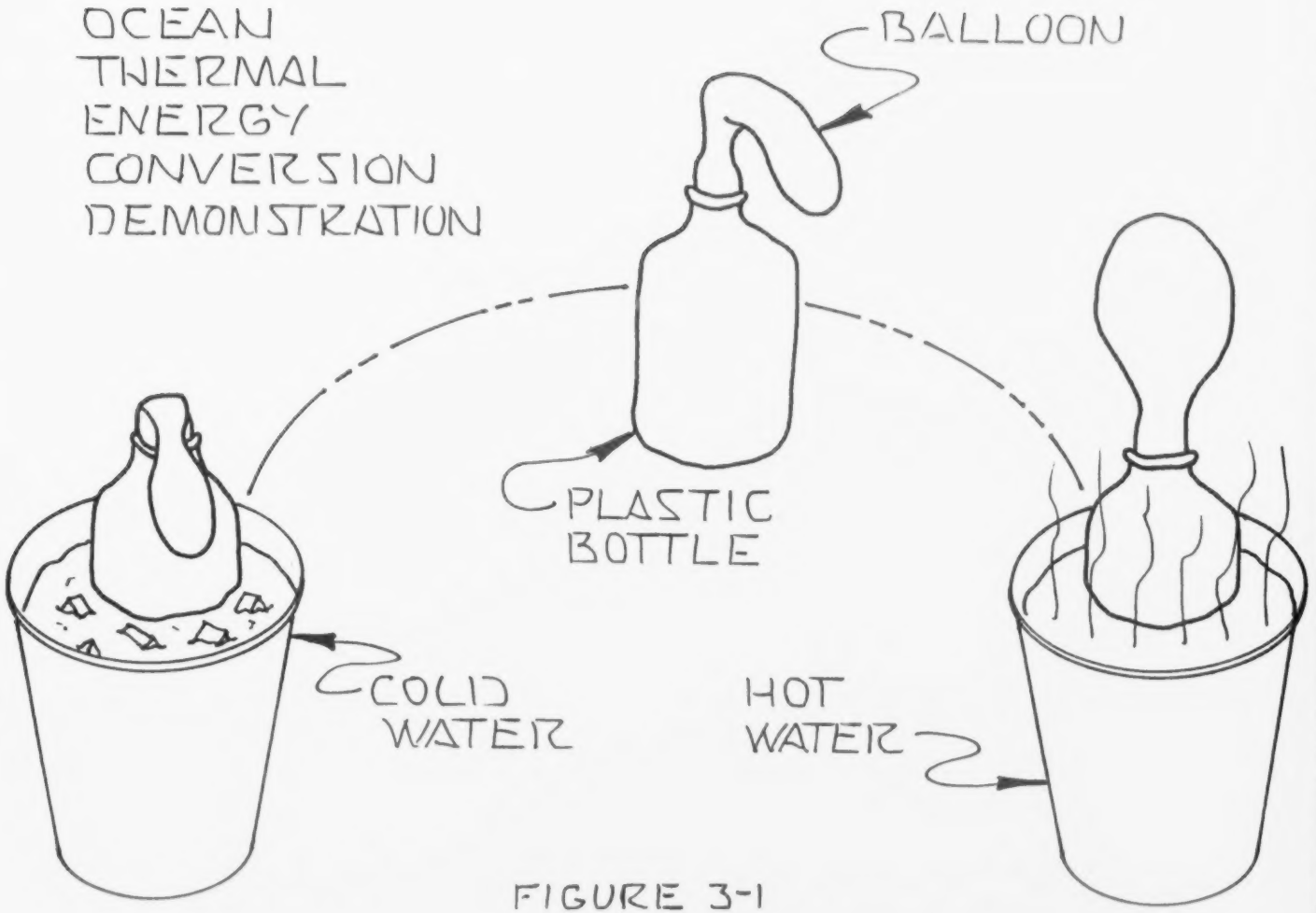
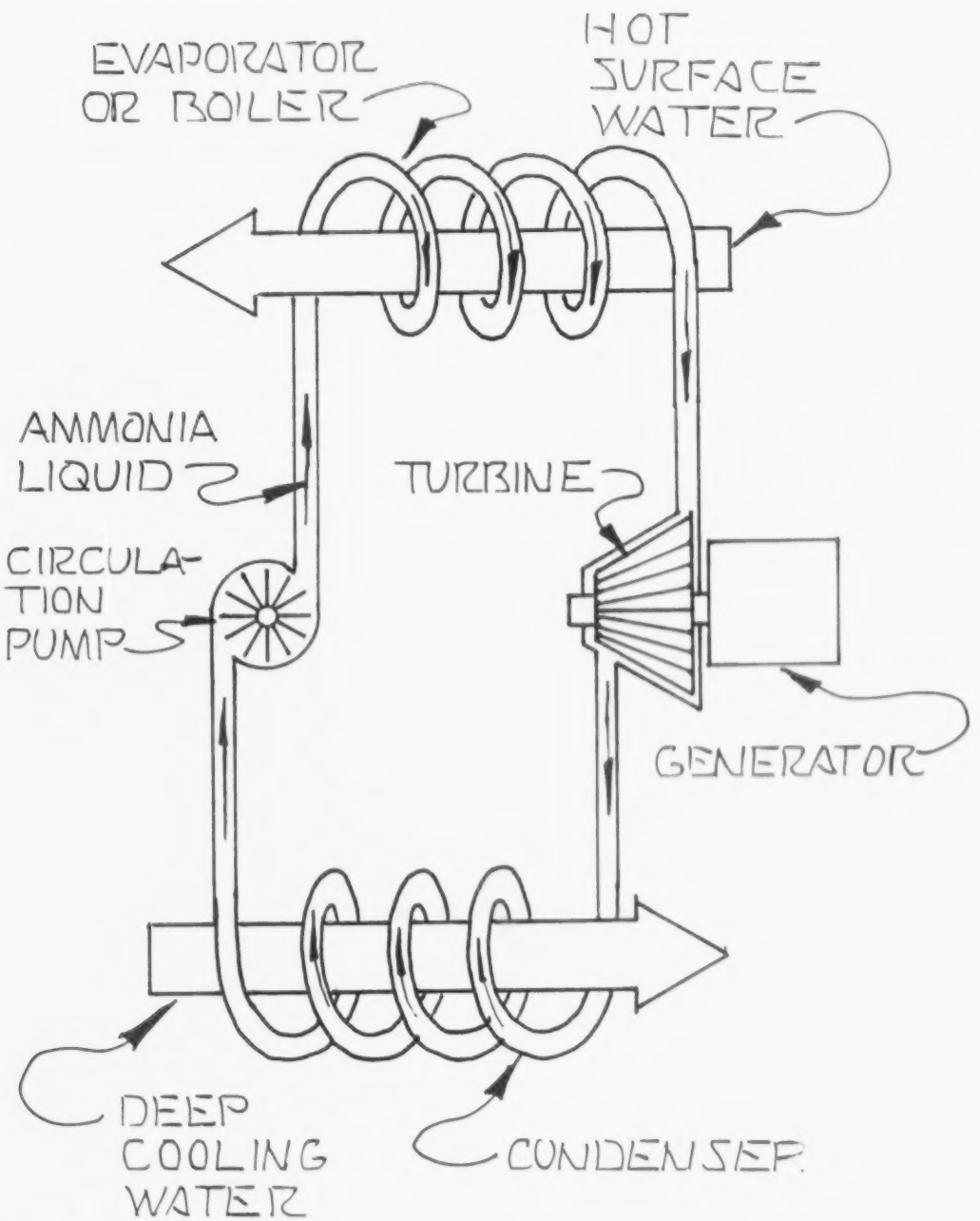

OCEAN
THERMAL
ENERGY
CONVERSION
DEMONSTRATION
BALLOON
PLASTIC
BOTTLE
COLD
WATER
HOT
WATER

FIGURE 3-1


EVAPORATOR OR BOILER
HOT SURFACE WATER
AMMONIA LIQUID
TURBINE
CIRCULA-TION PUMP
GENERATOR
DEEP COOLING WATER
CONDENSER

OCEAN THERMAL ENERGY CONVERSION (OTEC)

Discussion:

Ocean thermal energy conversion is another form of solar energy. In some parts of the world, the sun heats tropical ocean water on the surface to temperatures of about 80 degrees Fahrenheit. While the surface water is quite warm, water about 1000 feet down is about 40 degrees Fahrenheit. Ocean Thermal Energy Conversion uses the difference in water temperature to generate electricity. OTEC is still on the drawing boards. An operating OTEC power plant has never been built.

An OTEC power plant would basically be a gigantic floating platform with 50 foot wide pipes projecting down about 1000 feet below the surface. Warm water from the surface would be used to heat an ammonia liquid. At about 80 degrees Fahrenheit, the ammonia liquid expands into a gas. The expanded gas is under great pressure and would be used to drive large turbines. The turbines would turn a generator. The generator would convert the mechanical energy from the turbines into electrical energy. Cold water from deep in the ocean would be pumped up to the platform and used to cool the ammonia gas. When cooled, the ammonia becomes liquid again and the pressure is reduced. After the ammonia has been cooled, the cycle repeats.

There are several problems with the OTEC concepts that still have to be solved. The biggest problem is cost. There are only a few good sites for OTEC in the world. Most of these are far away from the shore. The most expensive problem is how to get the electricity produced off shore to the shore where it is needed. In addition, OTEC power plants would be subjected to sea water corrosion and damage from ocean storms. Once these problems have been solved, an OTEC plant could be built in 5 to 10 years. Some experts feel energy from an OTEC plant could provide 1 to 5 percent of the United State's energy requirements by the year 2000.

Learning Activities:

During a demonstration, you observed how a gas will expand and contract when subjected to hot and cold temperatures. Use the knowledge you gained during the demonstration, class discussion, and your reading to complete the flow chart on the following page illustrating the OTEC process.

Directions:

Complete the flow chart below by matching the OTEC elements listed at the top with their proper locations in the OTEC conversion process.

A. Cold water from the ocean bottom is used to condense the ammonia.

B. Electrical energy is brought to the consumer through a distribution grid.

C. Warm surface water expands the ammonia.

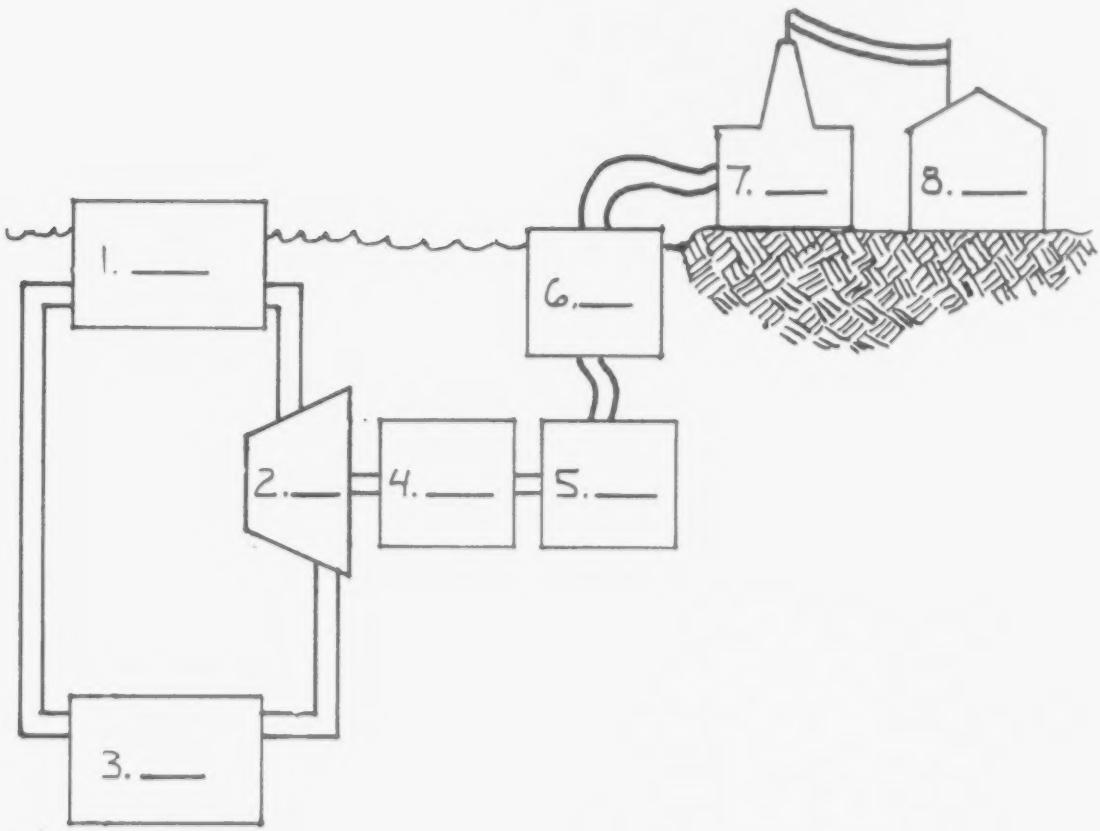
D. Mechanical energy from the expanded ammonia is used to turn a turbine.

E. Mechanical energy from the turbine is used to turn a generator.

F. The consumer utilizes the energy.

G. Electrical energy is brought to shore.

H. The generator converts mechanical energy into electrical energy



Unit: Using Alternate Energy Sources

Lesson 4: Geothermal Energy

Objectives	Lesson Content	Learning Activities	Ref.
A. Following a discussion, students will be able to: -identify a definition for geothermal energy. -identify three natural examples of geothermal energy. -identify descriptions of the three basic types of geothermal wells.	A. Geothermal Energy 1. Geothermal energy is heat energy from the earth's interior. 2. Origins of geothermal energy - two theories a. the earth is cooling and heat is trapped in the earth's core. b. the heat inside of the earth is caused by the decay of radioactive elements and from magma 3. Natural examples of geothermal energy a. volcanoes b. hot springs c. geysers 4. Locating geothermal deposits a. study geologic maps and satellite photos b. investigate earthquake and volcano areas c. measure how shock waves and electricity travel through the earth	A. Teacher Guided Discussion 1. Ask your students if any of them have seen a geyser, valcano, or a hot spring. Ask them to describe what they saw. Introduce the idea of tapping the heat energy trapped in the earth. 2. Using OT #4-1, discuss a definition for geothermal energy. 3. Using OT #4-2, discuss the two basic theories regarding the origins of geothermal energy. 4. Using OT #4-3, discuss the three basic natural examples of geothermal energy. 5. Using OT #4-4, discuss the process for locating geothermal deposits. 6. Using OT #4-5 through OT #4-7, introduce students to the three basic types of geothermal deposits. Discuss the advantages and disadvantages of each type of deposit. 7. Using OT 4-8, discuss the two basic applications for geothermal energy.	

d. drill shallow wells and study temperature and heat flow
e. drill and test deep wells to evaluate the potential of the site

5. Basic types of wells
   a. dry steam
   b. hot water
   c. dry rock
6. Dry steam wells
   a. contain little or no moisture
   b. economical to operate
7. Hot water wells
   a. super heated water
   b. contain minerals
8. Dry rock wells
   a. water must be pumped into the well
   b. hot water is returned to the surface
9. Geothermal energy applications
   a. generating electricity
   b. heating living space
10. Energy conversion process
    a. pipe geothermal steam from deposits to a power plant
    b. use the steam to drive turbines
    c. condense the steam and return waste water to the deposits
    d. convert the mechanical energy produced by the turbine into electrical energy through a generator
    e. distribute the electrical energy

8. Using OT #4-9, discuss the process used to convert geothermal energy to electrical energy.

B. Following a demonstration, in a lab activity, students will be able to:
- -make a steam driven generator using common materials.
- -conduct a geothermal energy conversion simulation according to written and verbal instructions.
- -accurately complete a flow chart illustrating the geothermal energy conversion process.

B. Making and testing a geothermal power plant simulator
1. Making a steam driven generator.
   a. making the turbine assembly
   b. making the generator assembly
   c. making the steam jet assembly
   d. assembling the steam generator on a base
2. Setting up the geothermal energy conversion simulation
   a. establishing a geothermal deposit
   b. linking the deposit to the generator
3. Conducting a simulation
   a. producing steam
   b. using the steam to turn the turbine
   c. using the turbine to generate electricity
   d. monitoring the amount of electricity generated
4. Completing the flow chart

B. Learning Activities
1. Demonstrate how to use the tools and materials needed to make a steam driven generator.
2. Demonstrate how to make the turbine, generator, and steam jet assemblies. Explain how to assemble the subassemblies into a working steam driven generator.
3. Explain how to set up a geothermal energy conversion simulation. Emphasize safety considerations.
4. Provide each student with HO #4-1 through 4-3.
5. Divide your class into groups of three to four students. Assign each group a work station.
6. Have students begin making their steam driven generators.
7. Circulate around the room and provide individual instruction as needed.

8. When students have finished their generators, have them conduct a geothermal energy conversion simulation.
9. When students have finished the simulation, have them complete their flow chart.
10. Collect and evaluate the generators, lab sheets, and flow charts.

GEOTHERMAL ENERGY

Preparation Hints:

1. Review the materials provided, duplicate HO #4-1, and prepare the transparencies needed to present this lesson.

2. During this lesson, your students will be making and testing steam driven generators. Prior to implementing this lesson, you will need to collect and organize the materials listed in the handout. The small hobby motors can be purchased from a local hobby store, or one of the many popular electronics or industrial arts vendors.

3. During the lab activity, your students will be using their steam driven generators to conduct a geothermal energy conversion simulation. You might need to borrow a variety of materials from your science department to simulate geothermal energy deposits. Each work station will need a beaker, a stopper with a hole in it, a section of glass tubing, about two feet of rubber hose, a beaker stand, and a heat source. The heat source can be a bunsen burner, alcohol burner, or sterno.

4. During the geothermal energy conversion simulation, your students will be making and condensing steam. To protect the working surfaces in your laboratory, ask several students to bring large baking tins from home. When setting up the simulation, ask students to put their generators inside the baking tins. During the simulation, condensed water will collect inside the baking tins.

5. Consider making a steam driven generator prior to implementing this lesson. Making your own generator will enable you to test your materials, identify problems, and develop strategies to ensure student success. In addition, students will be able to refer to your example when making their own generators.

Content Presentation Hints:

1. When discussing geothermal energy deposits, consider conducting a simple demonstration. Using everyday materials to represent the elements of a geothermal deposit, you can simulate the thermal energy trapped inside the earth. For the demonstration, you will need a hot plate, heavy duty aluminum foil, about three

inches of wire, a pot, and a few ounces of water (see Figure 4-1).

Put a little water into a frying pan and wire an aluminum foil lid on it. Leave a little room in the foil so it can rise when the water begins to boil. Punch a small hole in the foil using a large nail. Place the pot, water, and foil assembly on a hot plate. The hot plate represents magma in the earth's interior. The frying pan represents the rock in a geothermal deposit. The water in the frying pan represents the water found in a geothermal deposit. Lastly, the aluminum foil represents the many layers of earth above a deposit. The hole in the foil represents a well or geyser opening.

Ask students to describe what they think will happen when the water begins to boil. Discuss how the mock-up simulates a geothermal deposit within the earth. Ask students how they could tap the energy being released through the hole in the foil.

2. Consider showing your students a film or videotape on geothermal energy.

Learning Activity Hints:

1. If time or material considerations prevent students from being able to conduct their own geothermal energy simulation, consider conducting a class demonstration.

   Set up the demonstration according to Figure 4-3. Start heating the water in the beaker. While you are waiting for the water to boil, identify the role each component is playing in a geothermal energy system. The heat source and beaker of water represent a geothermal energy deposit. The stopper, tubing and hose represent the geothermal well and distribution system. The turbine assembly and motor/generator represents a geothermal power plant. The wire and volt meter represent power lines and the utility company's customers.

   Discuss how heat energy is being converted to mechanical energy, and how the mechanical energy is converted to electrical energy. Discuss how the waste water is handled in a real geothermal energy system.

2. When making steam driven generators, you may need to make several fine adjustments. For example, fill the copper tubing delivering steam to the turbine with solder. Drill a small hole in the solder to create a steam jet. Adjust the size of the opening to control the pressure needed to turn the turbine.

3. When linking the turbine assembly to the generator assembly, make sure both elements turn freely. The generator should turn if you blow a stream of air across the top of the turbine. Remove any tension between the turbine and generator by adjusting the metal strap holding the generator.

4. If your students are able to generate several volts during the geothermal energy simulation, consider connecting a small light bulb or LED to the generator. If the voltage produced is adequate, the bulb or LED should light. If the voltage produced by one geothermal energy simulation is inadequate, consider linking several generators in series. Connect a light bulb or LED to the network of generators. The energy produced by the network should be adequate to light the light bulb or LED.

5. Consider displaying one of the geothermal energy simulators in a location where the rest of the school community can see the results of your students' investigation into geothermal energy.

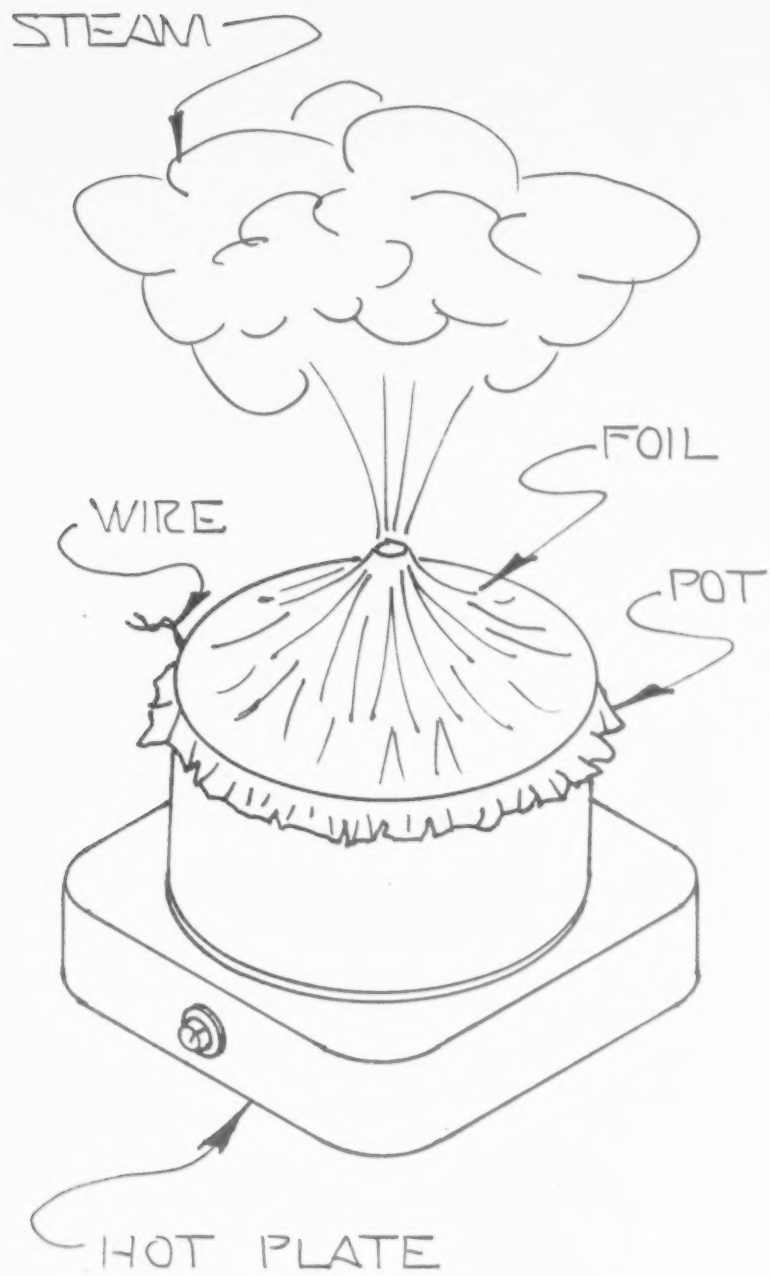


FIGURE 4-1
GEOTHERMAL ENERGY
SIMULATION

OT #4-1

GEOTHERMAL ENERGY:

Geothermal energy is heat energy from the earth's interior.

OT #4-2

ORIGINS OF GEOTHERMAL ENERGY:

* the earth is cooling and heat is trapped in the earth's core.

* the heat inside the earth is caused by the decay of radioactive elements and from magma.

OT #4-3

NATURAL EXAMPLES OF GEOTHERMAL ENERGY:

* volcanos
* hot springs
* geysers

OT #4-4

LOCATING GEOTHERMAL DEPOSITS:

* study geologic maps and satellite photos
* investigate earthquake and volcano areas
* measure how shock waves and electric waves travel through the earth
* drill shallow wells and study temperature and heat flow
* drill and test deep wells to evaluate the potential of the site

OT #4-5

DRY STEAM WELLS:

* contain little or no moisture
* economical to operate

OT #4-6

HOT WATER WELLS:

* super heated water
* contain minerals

OT #4-7

DRY ROCK WELLS:

* water must be pumped into the well
* hot water is returned to the surface

OT #4-8

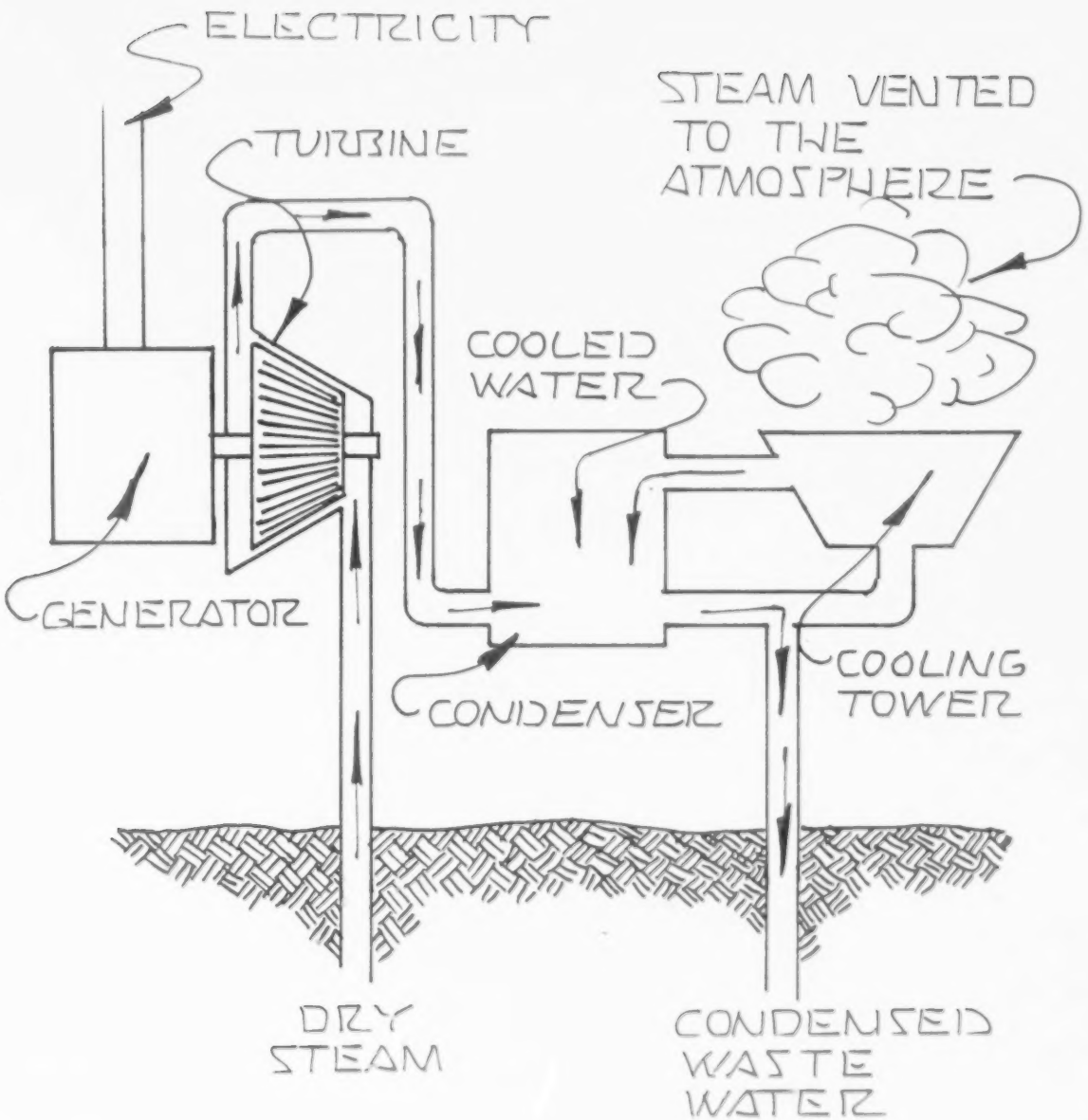
GEOTHERMAL ENERGY APPLICATIONS:

* generating electricity
* heating living space

OT #4-9

ENERGY CONVERSION PROCESS:

* pipe geothermal steam from steam to a power plant
* use the steam to drive turbines
* condense the steam and return waste water to the deposits
* convert the mechanical energy produced by the turbine into electrical energy through a generator
* distribute the electrical energy


ELECTRICITY
TURBINE
STEAM VENTED TO THE ATMOSPHEIRE
COOLED WATER
GENERATOR
CONDENSER
COOLING TOWER
DRY STEAM
CONDENSED WASTE WATER

GEOTHERMAL ENERGY

Discussion:

Geothermal energy is basically heat energy from inside the earth. There are two theories why there is heat below the earth's surface. The first theory is the earth is still cooling down from its creation. The second theory is the heat below the earth's surface is caused by the decay of radioactive elements and from magma (a mixture of rock and gases).

Temperatures inside the earth increase as the depth increases. Just below the earth's crust, temperatures between 400 and 1,950 degrees Fahrenheit can be found. Evidence of the heat trapped inside the earth can be seen on the earth's surface. Hot springs, geysers and volcanoes are examples of the heat energy within the earth.

Locating geothermal deposits requires a variety of tools. Geothermal deposits are typically found in areas of recent volcanic activity or mountain building. Locating specific deposits involves studying geologic maps and satellite photos. Studying the ways shock waves and electric waves travel through the earth can also help scientists and engineers locate deposits. Once a deposit has been located, shallow wells are drilled and temperature readings are taken. If the readings are good, deep exploratory wells are drilled to make sure the deposit can be used. Geothermal deposits have been found in the United States (California and Idaho), Italy, New Zealand, Iceland, Japan, Mexico, and the Soviet Union.

There are three basic types of geothermal deposits. The most ideal is a dry steam deposit. A dry steam deposit contains super heated steam that contains very little moisture. Power plants using dry steam are the most economical to operate. Hot water or wet steam deposits contain super heated water. The super heated water does not boil underground because it is under pressure. When the water is brought to the surface, the water becomes steam containing moisture and minerals. The last type of deposit is called a dry rock deposit. In order to take advantage of a dry rock deposit, water must be pumped into the well. The water pumped into the deposit first causes the rock to fracture. Additional water can be pumped into the fractured rock, converted to steam, and then brought back to the surface by a nearby well.

After a deposit has been located, a well must be drilled. Tapping a geothermal deposit often requires a well between 30,000 to 50,000 feet deep. After the well has been drilled, a power plant must be built. A geothermal power plant takes about three to five years to build. Once the power plant has been built, the steam from many wells must be piped to the power plant. The steam must be cleaned because it contains many corrosive contaminants and minerals.

There are two basic ways the steam can be used to drive turbines. The first one is called the flash method. Hot water from the well does not boil because it is under high pressure. When the pressure is reduced, some of the water is converted into steam. The steam is used to turn the turbines directly.

The second method used to turn the turbines is called the vapor-turbine method. In the vapor-turbine method, steam is not used to drive the turbines directly. The heat from the well water is transferred to a refrigerant material through a heat exchanger. The refrigerant material becomes a gas at a very low temperature. The heat from the hot water causes the refrigerant material to expand. Pressure from the expanded gas is used to drive the turbines.

The turbines convert the thermal energy of the steam into mechanical energy. The turbines are used to turn generators. The generators convert the mechanical energy from the turbines into electrical energy. Most of the geothermal power plants are located in remote areas. A long network of power lines are needed to bring the electricity to the populated areas.

Once the geothermal steam has been used to drive the power plant turbines, it condenses into water. The waste water from a geothermal power plant contains a high concentration of chemicals and sediment. Dumping the waste water into rivers and streams would result in a serious pollution problem. Therefore, the waste water is returned to the geothermal deposit in the ground by means of a second well.

Geothermal energy can also be used to heat homes and business. Hot water from the ground cannot be directly piped into people's homes because the minerals would clog the heating system. Heat exchangers are used to transfer the heat from from the geothermal water or steam to purified water from the public utility. The purified hot water is piped to radiators throughout the house or business. The radiators, in turn, heat the living space.

Geothermal power plants produce several forms of pollution. Most geothermal wells vent chemicals that cause the air to smell like rotten eggs. Escaping geothermal steam produces an earsplitting hiss. Geothermal power plants also release a lot of waste heat into the atmosphere. The pollution is not thought to be a big problem because geothermal power plants are not located near populated areas. The problems with geothermal energy are not as serious as the problems connected with coal and nuclear energy.

Geothermal energy comes from heat trapped inside the earth's interior. Natural examples of geothermal energy include volcanos, hot springs, and geysers. Locating geothermal deposits involves studying geographic maps and satellite photos, investigating earthquakes and volcano areas, measuring shock waves and electric waves traveling through the earth, and drilling and studying wells. The three basic types of geothermal deposits include dry steam wells, hot water wells, and dry rock wells. Geothermal energy can be used to generate electricity and heat living space.

Learning Activities:

To generate electricity with geothermal energy, thermal energy must be converted to mechanical energy, and the mechanical energy must be converted to electrical energy. During the following learning activities, you will be making and testing a steam driven generator. In addition, you will use your generator to conduct a geothermal energy conversion simulation. Using the knowledge gained during the simulation, you will complete a flow chart illustrating the geothermal energy conversion process.

MAKING AND TESTING A STEAM DRIVEN GENERATOR

Directions:

During this portion of the lab activity, you will be making a steam driven generator. Your steam generator will have three subsystems: a turbine assembly, a generator assembly, and a steam jet assembly. Assign each member of your team a subassembly. When the subassemblies are complete, assemble, adjust, and test your steam driven generator.

Making the Turbine Assembly:

1. To make the turbine assembly, you will need the following materials:

   * three pieces of galvanized sheet metal, 3" wide and 3" long
   * one piece of welding rod, about 2 1/2" long

2. Using the template provided, lay out a 3" diameter circle on one of the pieces of galvanized sheet metal. Using a pair of tin snips, cut out the circle.

3. Using a drill bit about the same size as the welding rod, drill a hole through the center of your 3" sheet metal disk.

4. Using the template provided, lay out the fins for your turbine. Place the template on top of the 3" sheet metal disk. Trace the lines identifying fins with a razor knife. After you have traced all the lines, remove the template. You should have a series of scratches representing the fins on your sheet metal disk.

5. Using a pair of tin snips, cut along the lines scribed into your sheet metal disk. When you have finished, gently twist each blade 90 degrees with a pair of pliers. To keep from distorting the disk, gently twist each blade 10 degrees at a time until you have reached 90 degrees.

6. Insert the welding rod through the turbine about one inch. Make sure the welding rod is perpendicular to the turbine. Solder the welding rod to your turbine using a soldering iron.

7. Using the template provided, lay out the turbine supports on the two remaining pieces of sheet metal. Cut

the supports out using a pair of tin snips. Use the template to locate the holes for the turbine shaft and the mounting screws on each support. Use a drill bit the same size as the welding rod to drill holes for the turbine shaft. Use a drill bit slightly larger than your screws for the mounting holes. Lastly, use a box-and-pan rake or vice to bend each support into shape.

Making the Generator Assembly:

1. To make the generator assembly, you will need the following materials:

   * one strip of sheet metal, 1/2" wide, about 8" long.
   * one small hobby motor
   * one #8 machine screw and nut

2. Wrap the sheet metal strip around the hobby motor so both ends meet. Pinch the strap so the hobby motor is held firmly. Lay out a hole for a machine screw near the hobby motor. Use a drill bit slightly larger than the machine screw to drill a hole through the metal strap. Insert the machine screw through the hole and fasten both halves of the sheet metal together with a nut.

3. Lay out holes for the mounting screws near the ends of the metal strap. Use a drill bit slightly larger than the mounting screws to drill the holes. Spread the two halves of the metal strap apart. Form the ends of the strap so the generator assembly looks like the one illustrated in the plan.

Making the Steam Jet:

1. To make the steam jet, you will need the following materials:

   * one piece of 1/4" copper tubing about 2" long
   * one strip of sheet metal, 1/2" wide and 3 1/2" long
   * one #8 machine screw and nut

2. Using a soldering iron, fill one end of the copper tubing with solder. After the solder cools, use a tiny drill bit to make a small hole in the middle of the solder.

3. Wrap the sheet metal strip around the copper tubing so both ends meet. Pinch the sheet metal strip so the copper tubing is held firmly. Locate a hole just beneath the copper tubing for a machine screw. Use a drill bit slightly larger than the machine screw to drill a hole through both halves of the sheet metal strap. Fasten both halves of the sheet metal strap together with a machine screw and nut.

4. Locate holes for the mounting screws near the ends of the sheet metal strap. Use a drill bit slightly larger than the mounting screws to drill the holes. Form the ends of the strap so the steam jet assembly looks like the one illustrated in the plan.

Assembling and testing your Steam Driven Generator:

1. To assemble your steam driven generator, you will need the following materials:

   * one piece of wood, 3/4" thick, 5" wide, and 5" long
   * eight #6 pan head screws, 1/2" long
   * one piece of wire insulation, about 3/4" long

2. Using a piece of wire insulation, connect the turbine shaft to the shaft on the hobby motor. Position the turbine assembly, generator assembly, and steam jet assembly on the piece of wood as illustrated in the plan. Locate and mark the holes for the mounting screws. After the holes have been marked, remove the assemblies. Using a drill bit slightly smaller than the mounting screws, drill a hole 1/2" deep at each mounting screw location. After the holes have been drilled, relocate each subassembly and install their mounting screws.

3. When your steam driven turbine has been assembled, it needs to be tested and adjusted. Try blowing a steam of air across the top of the turbine. The turbine should turn freely, rotate the turbine shaft by hand and look for unwanted friction or tension in the system. For example, the turbine shaft and the hobby motor shaft might not be properly aligned. You might need to adjust the metal strap holding the generator. Experiment with your generator until the turbine turns freely.

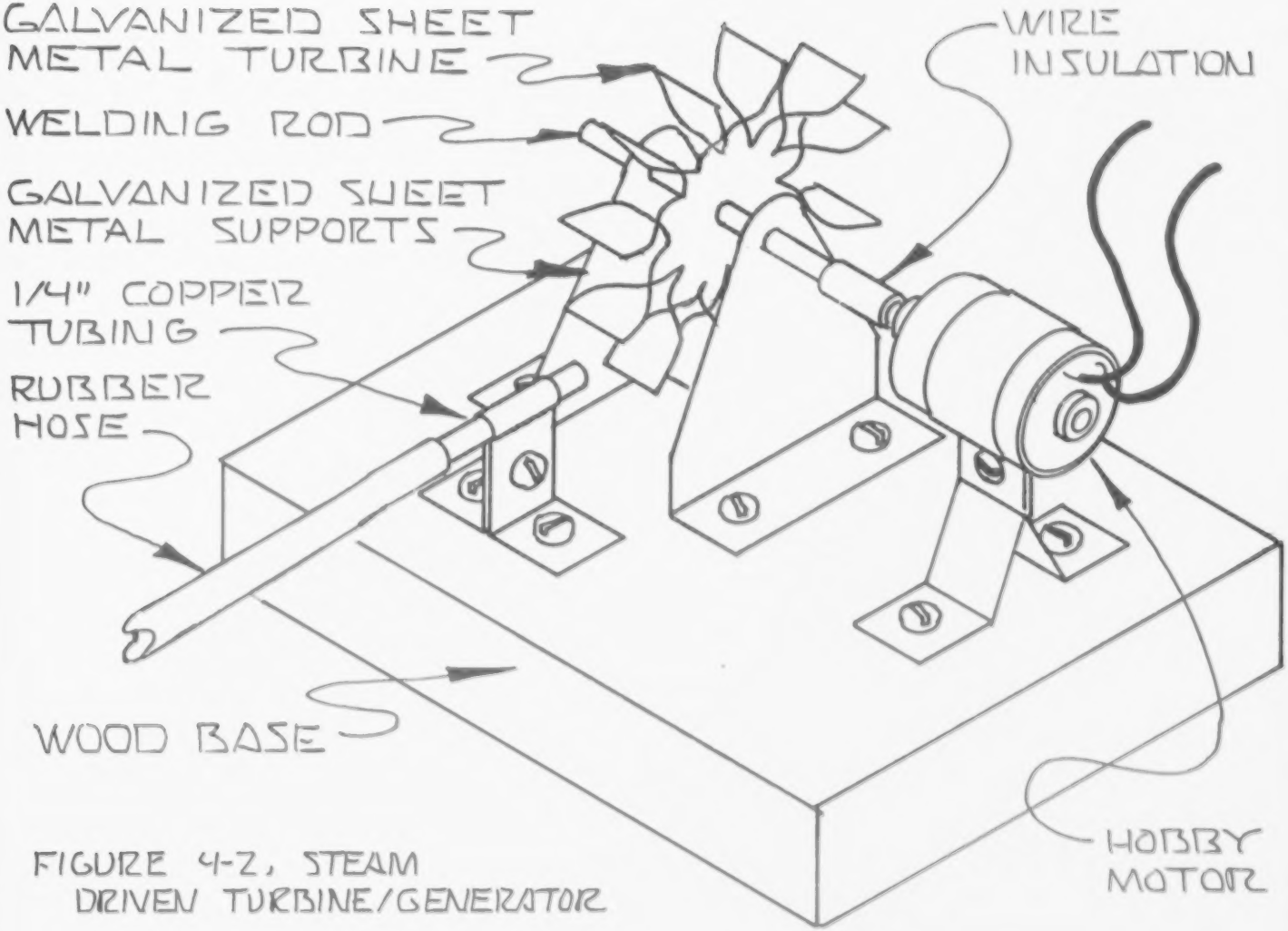
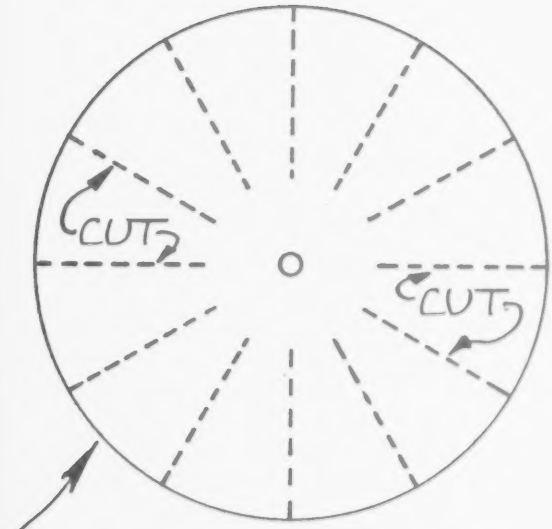
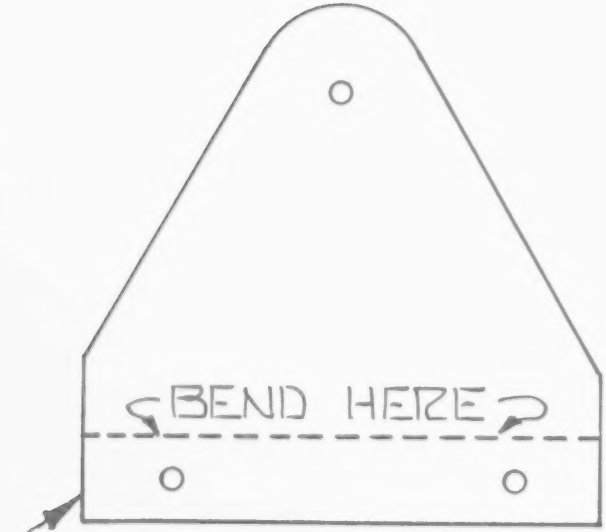


FIGURE 4-2, STEAM DRIVEN TURBINE/GENERATOR



TEMPLATE: TURBINE



TEMPLATE: TURBINE SUPPORTS

Conducting Geothermal Energy Conversion Simulation:

Directions: During this portion of the lab activity, you will be conducting a geothermal energy conversion simulation. Work as a team when setting and conducting the simulation. Observe all safety rules and wear eye protection during the simulation.

1. To conduct a geothermal energy conversion simulation, you will need the following materials:

   * one beaker
   * one stopper with a hole in it for glass tubing
   * one piece of glass tubing
   * one length of rubber hose, about 20" long
   * one alcohol burner or can of sterno
   * two jumper leads
   * one volt meter and/or milliamp meter
   * one baking pan
   * one steam driven generator
   * one beaker stand

2. Put your steam driven turbine inside the baking pan (see Figure 4-3). Place the beaker on its stand and position your heat source under the beaker. Pour about six ounces of water into the beaker. Install a piece of glass tubing in the rubber stopper. Cap the beaker with the rubber stopper. Connect the glass tubing coming from the beaker to your steam driven turbine with the rubber hose.

3. Using the jumper leads, connect the generator to a volt meter or milliamp meter. Connect the positive terminal of the generator to the positive terminal of the meter. Connect the negative terminal of the generator to the negative terminal of the meter. Turn the turbine shaft in the same direction it will be turned when driven by steam. The needle on your meter should move into the dial. If it does not move, switch the wires on the meter. Try rotating the turbine shaft again. If the needle still does not move, ask your instructor for assistance.

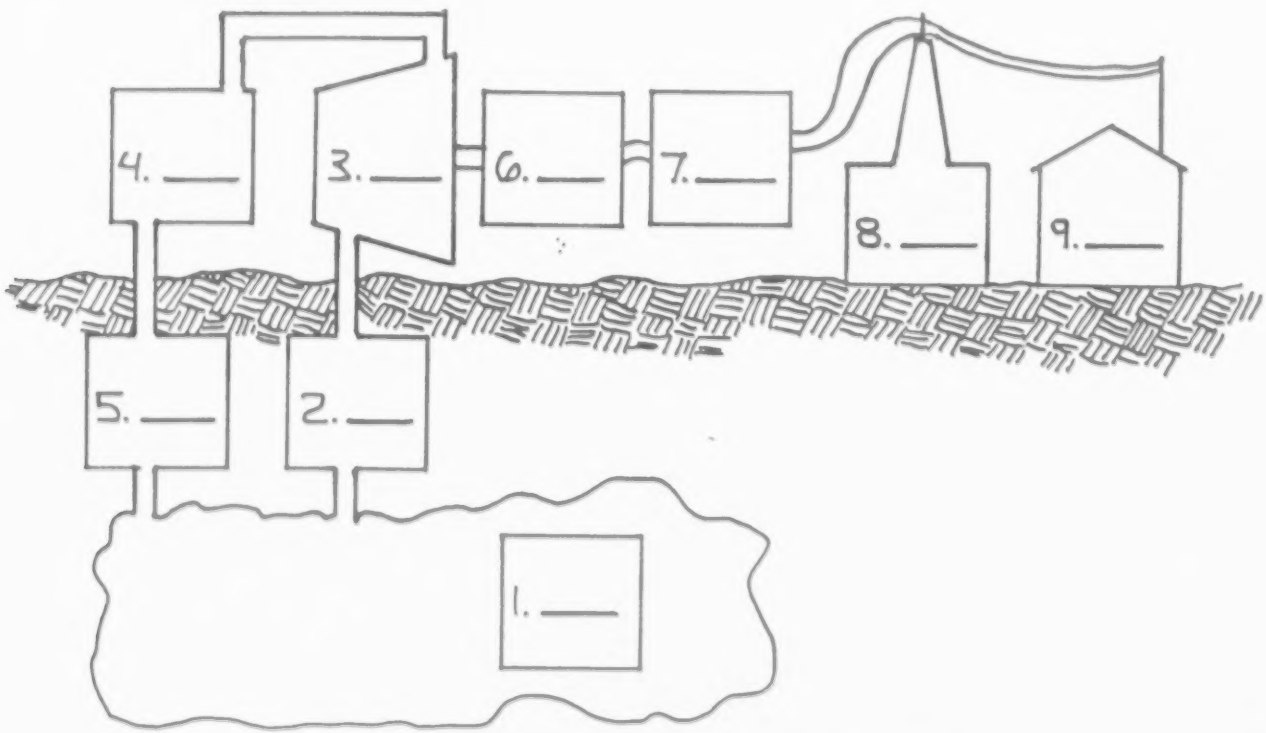
4. When your simulation is set up and your instructor has approved it, light the alcohol burner or can of sterno. After the water begins to boil, you will soon be producing steam. When the water is under full boil, the pressure produced by the steam jet should rotate the turbine and generator. When the turbine reaches full speed, read your meter, and record the voltage or current in the space below.

   _____

5. After your have taken your meter reading, extinguish the alcohol burner or can of sterno. Once the components have cooled, disassemble your geothermal simulation and clean up your work station according to your teacher's instructions.

6. Complete the flow chart by matching the geothermal elements (listed at the top) with their proper location in the geothermal conversion process.

A. Used steam is condensed in a cooling tower.
B. The electrical energy is brought to the consumer by means of a distribution grid.
C. Mechanical energy from the turbine is used to turn a generator.
D. Super heated steam is brought to the surface by means of a well.
E. The consumer utilizes the energy to perform work.
F. The generator converts mechanical energy to electrical energy.
G. The super heated steam is used to turn a turbine.
H. Super heated steam is trapped underground in a geothermal deposit.
I. Contaminated water is returned to the geothermal deposit by means of a second well.



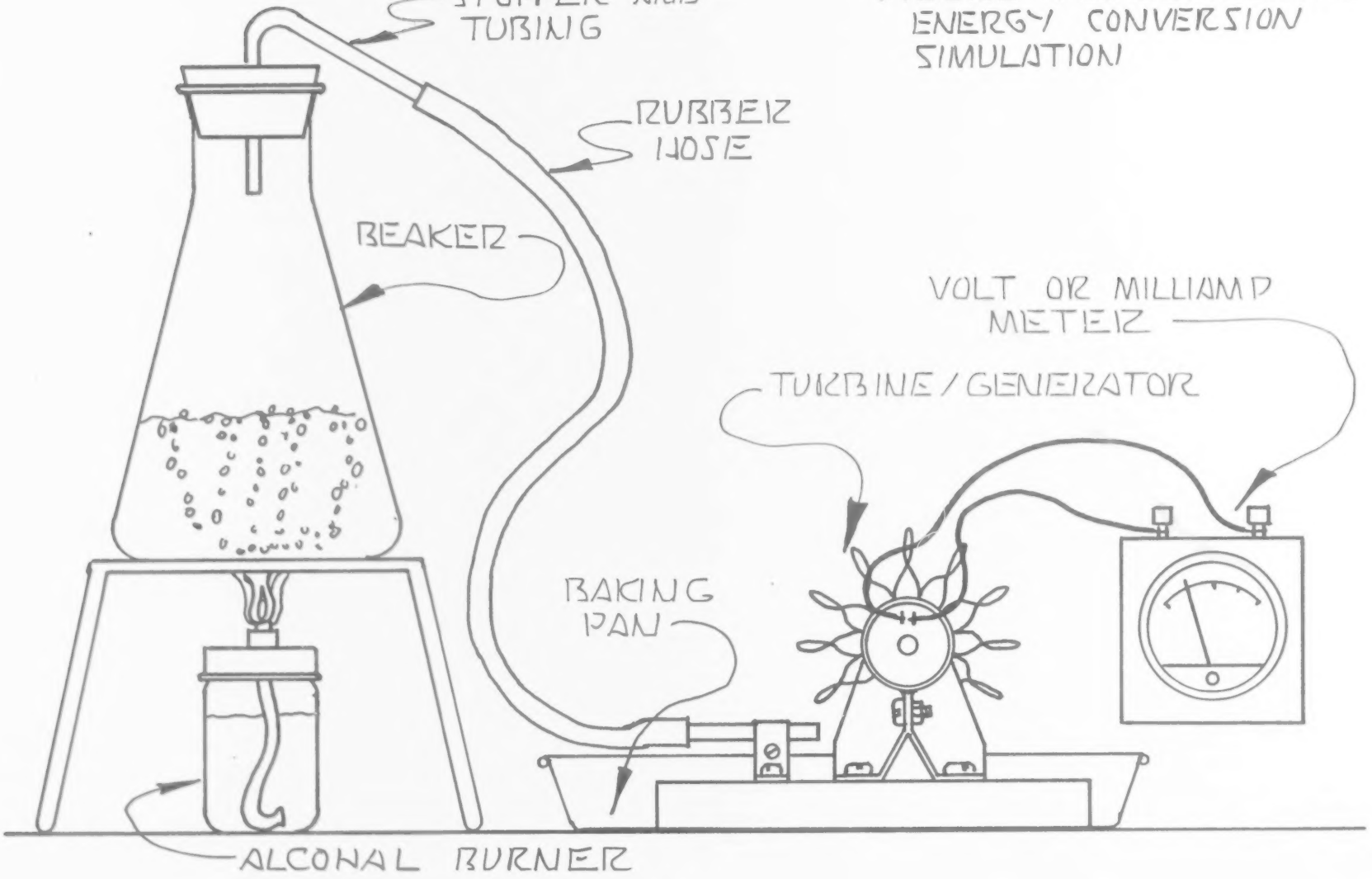


FIGURE 4-3, GEOTHERMAL ENERGY CONVERSION SIMULATION

Unit: Using Alternate Energy Sources

Lesson 5: Biomass Energy

Objectives	Lesson Content	Learning Activities	Ref.
A. Following a discussion, students will be able to: -identify a definition for biomass. -identify basic examples of biomass energy resources. -identify the three basic processes for converting biomass energy. -identify the advantages and disadvantages of biomass energy.	A. Biomass Energy 1. Biomass energy is a. a form of solar energy b. energy from organic materials c. energy from waste materials 2. Organic Materials a. trees b. sugar cane c. cassava d. sorghum e. corn f. algae g. kelp h. water hyacinth 3. Waste materials a. animal waste b. municipal sewage c. garbage 4. Converting Biomass Energy a. metabolic conversion (eating food) b. direct combustion (burning) c. bioconversion (making biofuels) 5. Biomass Fuels a. biogas (methane) b. alcohol (ethanol and methanol) c. petroleum d. solid fuels	A. Teacher Guided Discussion 1. Ask students to identify the energy resource their body uses to maintain life. Discuss how the food they eat contains energy that can be traced back to the sun. 2. Using OT #5-1, discuss a definition for biomass energy. 3. Using OT #5-2 and 5-3, discuss the organic and waste materials used in biomass energy systems. 4. Using OT #5-4, discuss the three basic methods for converting biomass energy. 5. Using OT #5-5, discuss the four basic examples of biomass fuels. 6. Using OT #5-6, discuss the advantages of biomass energy. 7. Using OT #5-7, discuss the advantages of biomass energy. 8. Using OT #5-8, introduce students to four basic examples of biomass energy.	

6. Advantages of biomass energy
   a. is a renewable energy resource
   b. converts waste materials into usable energy.
7. Disadvantages of biomass energy
   a. requires careful management
   b. requires a lot of land
   c. requires a lot of input energy
8. Examples of biomass energy
   a. heating homes with wood
   b. powering automobiles with gasahol
   c. burning solid trash to generate electricity
   d. using landfills to produce biogas

B. Following a demonstration, in a lab activity, students will be able to:
-process waste paper into a combustible fuel.
-complete a flow chart illustrating the biomass energy process.

B. Biomass energy project
1. Gathering waste paper
2. Processing waste paper
   a. cutting the paper into tiny pieces
   b. soaking the paper in warm water.
   c. pressing the paper into a container
   d. draining the water off
   e. drying the biomass
3. Burning the biomass material

B. Learning Activity
1. Explain the procedure for gathering waste paper
2. Demonstrate how to process the paper into a biomass material that can be burned.
3. Provide students with HO #5-1, divide your class into groups of three or four students and assign each group a work station.
4. Have students begin making their biomass fuel.
5. Circulate around the room and provide individual instruction as needed.
6. When students have completed their biomass fuels, allow the materials to dry for several days.
7. Have students complete the flow chart provided.
8. If time and facilities allow, test one of the biomass products.
9. Collect and evaluate your students' flow charts.

OT #5-1

BIOMASS ENERGY IS:

* a form of solar energy
* energy from organic materials
* energy from waste materials

OT #5-2

ORGANIC MATERIALS:

* trees
* sugar cane
* cassava
* sorghum
* corn
* algae
* kelp
* water hyacinth

OT #5-3

WASTE MATERIALS:

* animal waste
* municipal sewage
* garbage

OT #5-4

CONVERTING BIOMASS ENERGY

* metabolic conversion (eating food)
* direct combustion (burning)
* bioconversion (making biofuels)

OT #5-5

BIOMASS FUELS:

* biogas (methane)
* alcohol (ethanol and methanol)
* petroleum
* solid fuels

OT #5-6

ADVANTAGES OF BIOMASS ENERGY:

* is a renewable energy source
* converts waste materials into usable energy

OT #5-7

DISADVANTAGES OF BIOMASS ENERGY:

* requires careful management
* requires a lot of land
* requires a lot of input energy

OT #5-8

EXAMPLES OF BIOMASS ENERGY:

* heating homes with wood
* powering automobiles with gasahol
* burning solid trash to generate electricity
* using landfills to produce biogas

BIOMASS ENERGY

Presentation Hints:

1. Review the materials provided, duplicate HO #5-1, and prepare the transparencies needed to present this lesson.

2. During the lab activity, your students will be making biomass fuel. The purpose of the project is to help students understand that there are possible energy sources around them in the form of waste. The final product will be a fireplace log made out of pressed waste paper. For this project, you will need waste paper, scissors, water, plastic food containers, and aluminum foil. The waste paper and scissors should not be a problem in a school. Have each student bring a large plastic food container and enough aluminum foil to line it with from home. You will need several extra plastic containers to hold water for each work station. In addition, you may want newspapers to spread out over work benches and to use as waste paper.

Content Presentation Hints:

1. Show students a variety of biomass fuels. Your examples could include things like alcohol, gasohol, pelletized wood particles, fire wood, compressed straw or hay, and if you are real brave, manure.

2. Consider showing your students a film or videotape on biomass energy.

Learning Activity Hints:

1. The learning activity provided accurately represents the technological processes that go into densifying biomass fuel. This process is often called DBF. The DBF process typically includes shredding, compressing, and drying combustible materials. This is the reason for cutting the paper into tiny pieces, soaking it in warm water, pressing it into a mold, and allowing the biomass to dry. However, an equally combustible biomass product can be made by soaking full sheets of newspaper in water, rolling it into a log, tying it with string, and allowing it to dry.

2. Consider burning an example biomass product in a barbeque grill. If you have access to more than one barbeque grill, consider burning equal quantities of wood and/or charcoal at the same time.

3. Consider conducting a controlled experiment comparing your homemade biomass fuel with wood and/or charcoal. Use barbeque grills of similar design. Apply equal amounts of charcoal lighter to each example. Place equal quantities of water on top of each burning sample. Make sure the containers holding the water have equal dimensions. Place a thermometer in each container of water. Read and record the water's temperature every minute until all three samples have stopped boiling. Plot a graph illustrating the temperature readings for each fuel sample. Determine which fuel maintained the highest water temperature for the longest period of time.

4. Conduct this learning activity on a sunny day so the biomass fuel products can be dried in the sun. Drying the biomass fuel products indoors can result in undesirable humidity.

BIOMASS ENERGY

Discussion:

Plants represent an indirect form of solar energy. About 0.1 percent of the solar energy striking the earth is stored in its plant life. Plants can provide a useful form of energy. Plants that are good for energy applications are called biomass. Examples of biomass include trees, sugar cane, cassava, sorghum, and corn. Examples of biomass from aquatic plants include algae, kelp, and water hyacinth. In addition to plants, animal waste, municipal sewage, and garbage are also considered biomass. In every case, biomass materials once grew in sunlight and store solar energy through a process called photosynthesis.

One of the most direct ways of converting biomass materials into energy is called metabolic conversion. Metabolic conversion basically means eating and digesting biomass materials. When we eat and digest food from plants, our bodies convert the biomass into the energy we need to live. Another direct way of converting biomass into energy is by direct combustion (burning it). Burning wood is the most commonly used form of biomass energy other than food. Many third world countries rely on wood as their main energy resource.

Biomass materials can be converted into more useful forms of energy called biofuels. Converting biomass into biofuels is called bioconversion. Many experts hope biofuels will reduce our need for petroleum in the future. Examples of biofuels include methane gas, alcohol, and petroleum.

One advantage biomass has over many other forms of energy is it is a renewable energy resource. Renewable energy resources must be managed properly. For example,the process of cutting down trees for firewood must also include planting trees for the future. If too many trees are cut down without planting new trees, someday we will not have trees large enough for firewood, lumber or paper. A careful balance between harvesting and planting must be maintained. Another advantage to biomass energy is that it can turn what would otherwise be waste into usable energy.

Biomass energy requires a lot of land. If the state of Arizona were planted with a high energy crop, it could only provide one-tenth of the energy now being provided by fossil fuels in the United States. In addition to land, biomass energy requires a lot of energy. Energy is needed to plant,

grow, harvest, transport, process and convert a high energy crop. Sometimes, more energy is needed to develop an energy crop than the energy crop has to offer in the end.

Many forms of biomass energy are now being used in the United States. About one-fifth of the homes in the New England area are being heated with wood. Over half of the homes in New England use wood as a supplementary means of heating.

In many areas of the United States, gasohol is being used to power automobiles. Gasohol is 10 percent alcohol and 90 percent gasoline. The alcohol comes from an energy crop like corn, cassava, or sorghum. Gasohol can play a very big role in conserving petroleum energy resources.

Waste disposal is a big problem in many cities. Many cities have solved the problem by burning solid trash and using the heat to drive turbines and generate electricity. The City of Los Angeles has tapped its landfills to heat homes. Landfills are basically large pits in the ground. Garbage is dumped into the pits. When full, the garbage is buried by filling the pit with the dirt. Since the garbage is decaying underground without air, a biogas is produced. The biogas is burned and the heat is used to heat homes.

Biomass energy is energy from organic and waste materials. Biomass energy can be converted through metabolic conversion, direct combustion, or bioconversion. Examples of biomass fuels include biogas, alcohol, petroleum, and solid fuels. Biomass energy is renewable and can be used to process waste. However, biomass energy resources require careful management, land, and energy. Biomass fuels can be used to heat living space, power automobiles, and generate electricity.

Learning Activities:

Combustible materials can be processed into solid fuel using a process called densifying biomass fuel or DBF. During this process, combustible materials are shredded, compressed, and dried. During this learning activity, you will process waste paper into a solid fuel that can be burned in a barbeque grill, fireplace, or wood stove.

The first step in processing the waste paper is to cut it into small pieces no bigger than 2 inches square. Place the squares of paper into a container of water and allow them to soak for a few minutes. While the first batch of paper is soaking, line the plastic food dish with aluminum foil.

Put the soaked pieces of paper in the dish so each layer will overlap. With every other layer, use a piece of scrap to press the excess water out of the waste paper. Continue adding layers of wet paper to the dish until it is about one inch thick. Press the mass one last time and drain off as much water as possible. Allow the waste paper mass to dry in its aluminum liner. Because of greater density, the finished fireplace logs should burn slower than unprocessed waste paper.

After you have finished your biomass log, complete the flow chart below. Match the biomass elements listed at the top with their proper location in the biomass conversion process.

A. Transport the biomass materials for processing

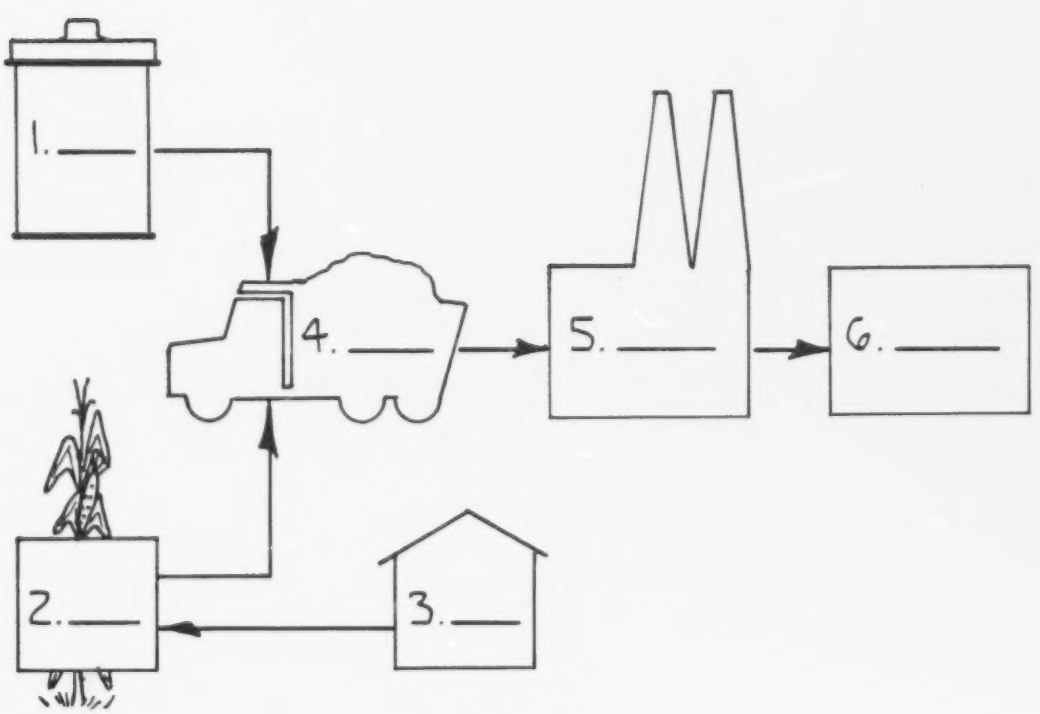
B. Utilize biofuels to heat living space, power automobiles, and/or generate electricity.

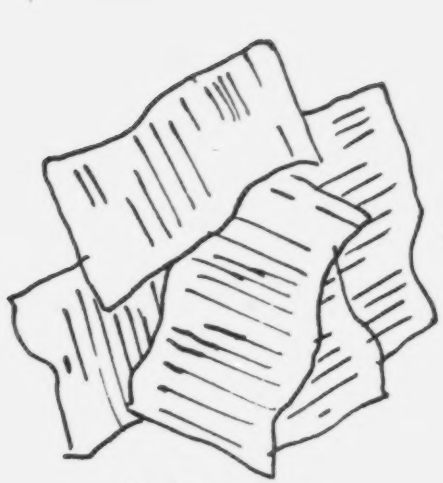
C. Collect waste materials.

D. Process the biomass materials into usable biofuels.

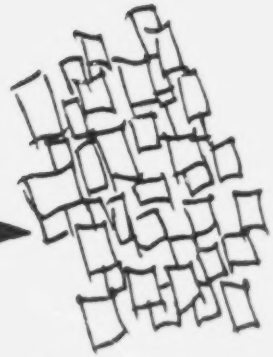
E. Manage the production and harvesting of organic materials.

F. Produce and harvest organic materials.



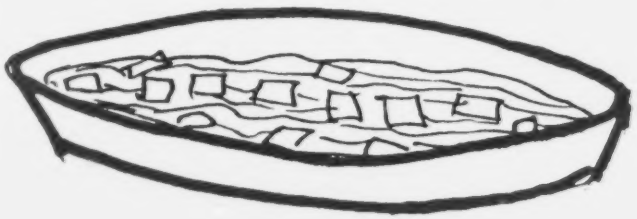


WASTE PAPER

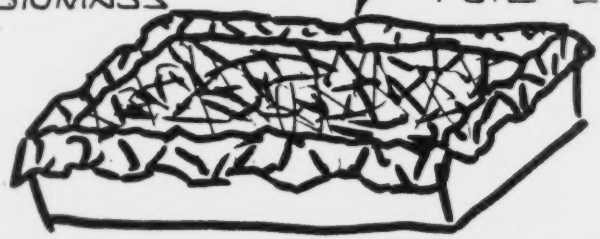


CUT THE PAPER INTO TINY PIECES

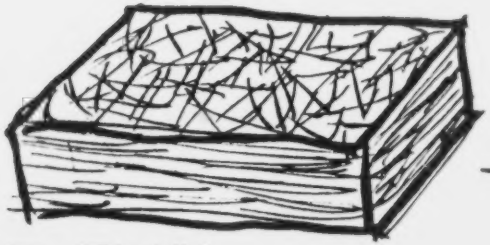
SOAK THE PAPER IN WARM WATER



PRESS THE PAPER INTO AN ALUMINUM FOIL LINED BAKING DISK



DRAIN THE WATER OFF AND LET THE BIOMASS DRY



THE FINAL PRODUCT: A DENISE MATERIAL THAT WILL BURN LIKE WOOD

Unit: Using Alternate Energy Sources

Lesson 6: Water Power

Objectives	Lesson Content	Learning Activities	Ref.
A. Following a discussion, students will be able to: -identify a definition for water power. -list six examples of moving water. -identify the forces that cause water to move. -identify descriptions of the four basic types of water power technologies. -identify how mechanical energy is converted into electrical energy in a hydroelectric power plant. -identify the advantages and disadvantages of water power as an alternative energy resource.	A. Water Power 1. is harnessing the energy in moving water 2. Examples of moving water a. rivers b. streams c. water through dams d. ocean currents e. tides f. waves 3. Forces that cause water to move a. gravity (hydroelectric b. wind energy (wave power) c. the moon (tidal power) d. difference in temperature (ocean current energy) 4. Energy conversion process a. moving water has mechanical energy b. turbines are used to harness the mechanical energy c. rotating turbines are used to drive generators d. generators convert mechanical energy into electrical energy	A. Teacher Guided Discussion 1. Introduce students to the concept of water power. 2. Using OT #6-1, discuss a definition for water power. 3. Using OT #6-2, discuss various examples of moving water. 4. Using OT #6-3, discuss the forces that cause water to move. 5. Using OT #6-4, discuss the energy conversion process for water power. 6. Using OT #6-5, discuss the four basic types of water power technologies. 7. Using OT #6-6 and 6-7, discuss the advantages and disadvantages of water power technology.	

5. Examples of water power
   a. hydroelectric power
   b. tidal power
   c. wave power
   d. ocean current energy
6. Advantages
   a. very efficient
   b. no water or air pollution
   c. cheap energy for the consumer
7. Disadvantages
   a. building hydroelectric power plants often results in flooding of farmland, timberland, and wild life habitats.
   b. reservoirs for hydroelectric power plants fill up with silt that must be removed.
   c. there are a limited number of good sites for hydroelectric, wave, and tidal power plants.

B. Following a demonstration, in a lab activity, students will be able to: -conduct a water power energy conversion simulation. -accurately complete a flow chart illustrating the water power energy conversion process.	B. Simulating the water power energy conversion process. 1. Setting up a water power simulation. a. positioning the turbine/generator assembly near a water source. b. connecting a water source to the turbine/generator assembly c. connecting a meter to the turbine/generator 2. Conducting the simulation. a. turn on the water b. apply water pressure to the turbine c. monitor the electricity being generated 3. Completing a flow chart illustrating the energy conversion process	B. Learning Activities 1. Demonstrate how to set up a water power simulation. Explain how to connect the turbine/generator to a water source and a meter. 2. Explain the role of each component in the water power simulation. 3. Demonstrate how to conduct the water power simulation. Explain how to control the amount of water pressure in the system. 4. Provide students with HO #6-1. 5. Divide your class into groups of three to four students. Assign each group a work station. 6. Have students conduct their water power simulations. 7. Circulate around the room and provide individual instruction as needed. 8. When students have finished their simulations, have them complete the flow chart illustrating the water power energy conversion process.

9. When students have finished their flow charts, discuss the energy conversion process.
10. Collect and evaluate your students' water power lab sheets and flow charts.

OT #6-1

WATER POWER:

* is harnessing the energy in moving water

OT #6-2

EXAMPLES OF MOVING WATER:

* rivers
* streams
* water through dams
* ocean currents
* tides
* waves

OT #6-3

FORCES THAT CAUSE WATER TO MOVE:

* gravity (hydroelectric)
* wind energy (wave power)
* the moon (tidal power)
* difference in temperature (ocean current energy)

OT #6-4

ENERGY CONVERSION PROCESS:

* moving water has mechanical energy
* turbines are used to harness the mechanical energy
* rotating turbines are used to drive generators
* generators convert mechanical energy into electrical energy

OT #6-5

EXAMPLES OF WATER POWER:

* hydroelectric power
* tidal power
* wave power
* ocean current energy

OT #6-6

ADVANTAGES OF WATER POWER:

* very efficient
* no water or air pollution
* cheap energy for the consumer

DISADVANTAGES OF WATER POWER:

results in flooding of farmland, timberland, and wildlife habitats.

* reservoirs for hydroelectric power plants fill up with silt that must be removed.
* limited number of good sites for hydroelectric, wave, and tidal power plants.

WATER POWER

Preparation Hints:

1. Review the materials provided, duplicate HO #6-1, and prepare the transparencies needed to present this lesson.

2. During the lab activity, your students will be conducting a water power energy conversion simulation. Your students will need to make turbine/generator assemblies before they can conduct the simulation. Use the plans provided in the geothermal lesson to conduct turbine/generators if you have not already done so.

3. During the water power energy conversion simulations, your students will need access to water under pressure. Prior to implementing this lesson, you will need to construct a means to distribute water to several work stations. Refer to Figure 6-1 for an example.

4. Since this lab activity involves water, you need to protect the working surfaces in your laboratory. Ask several students to bring large baking tins from home. When setting up the simulation, ask students to put their generators inside the baking tins. During the simulation, water will collect inside the baking tins. A second option is to conduct the simulation outdoors. Use a hose bib on the outside of your school building for the water source.

Content Presentation Hints:

1. Consider showing your students a film or videotape on hydroelectric power, tidal power, wave power, and/or ocean current energy.

2. Consider taking your class to the library for one class period, dividing your class into four groups. Assign each group a water power topic. One group could gather information about hydroelectric power, while other groups could explore tidal power, wave power, and ocean current energy.

3. Hydroelectric and tidal energy depend on both potential and kinetic energy. Wave and ocean current energy are forms of kinetic energy. Define, discuss, and demonstrate the concepts of potential and kinetic energy. Describe potential energy as energy due to position, and kinetic energy as energy due to motion.

Learning Activity Hints:

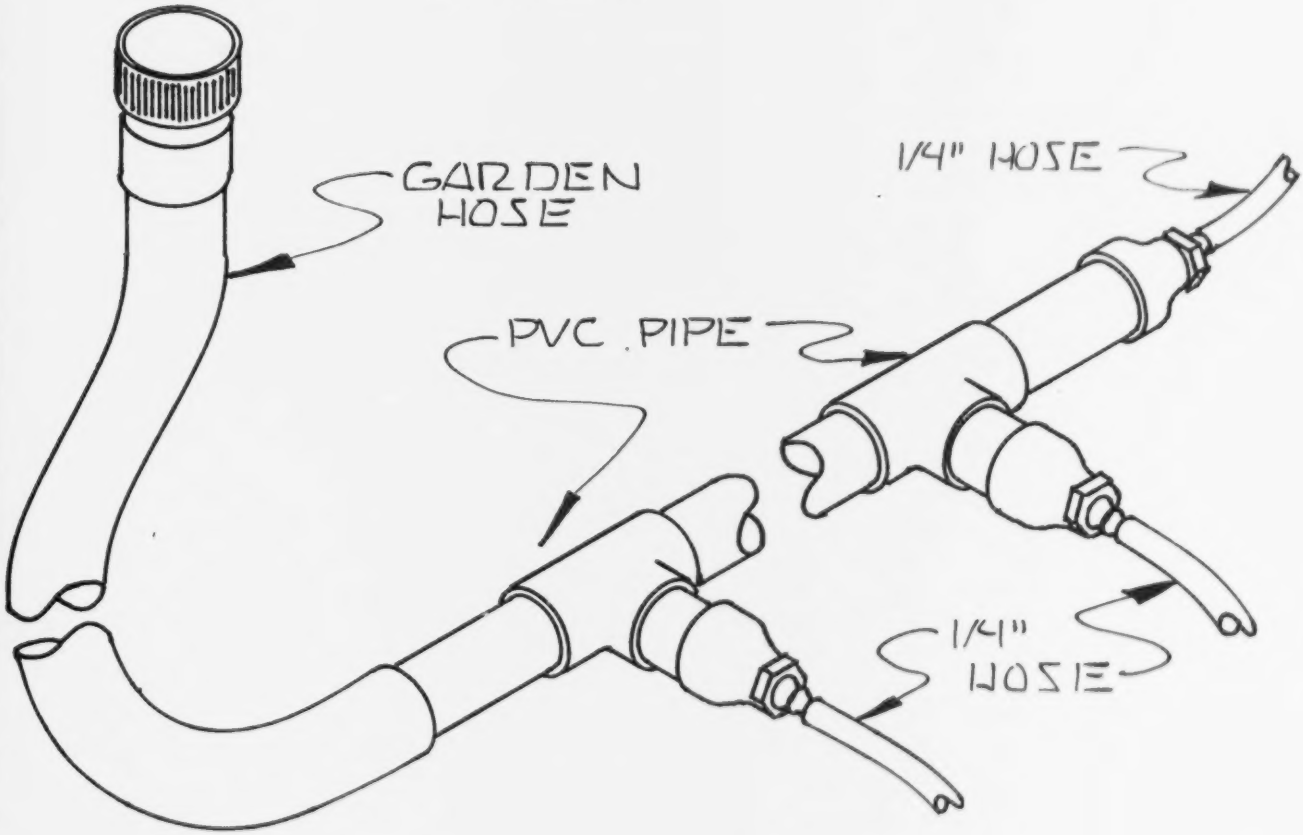
1. If time or material considerations prevents students from being able to conduct their own water power simulations, consider conducting a class demonstration.

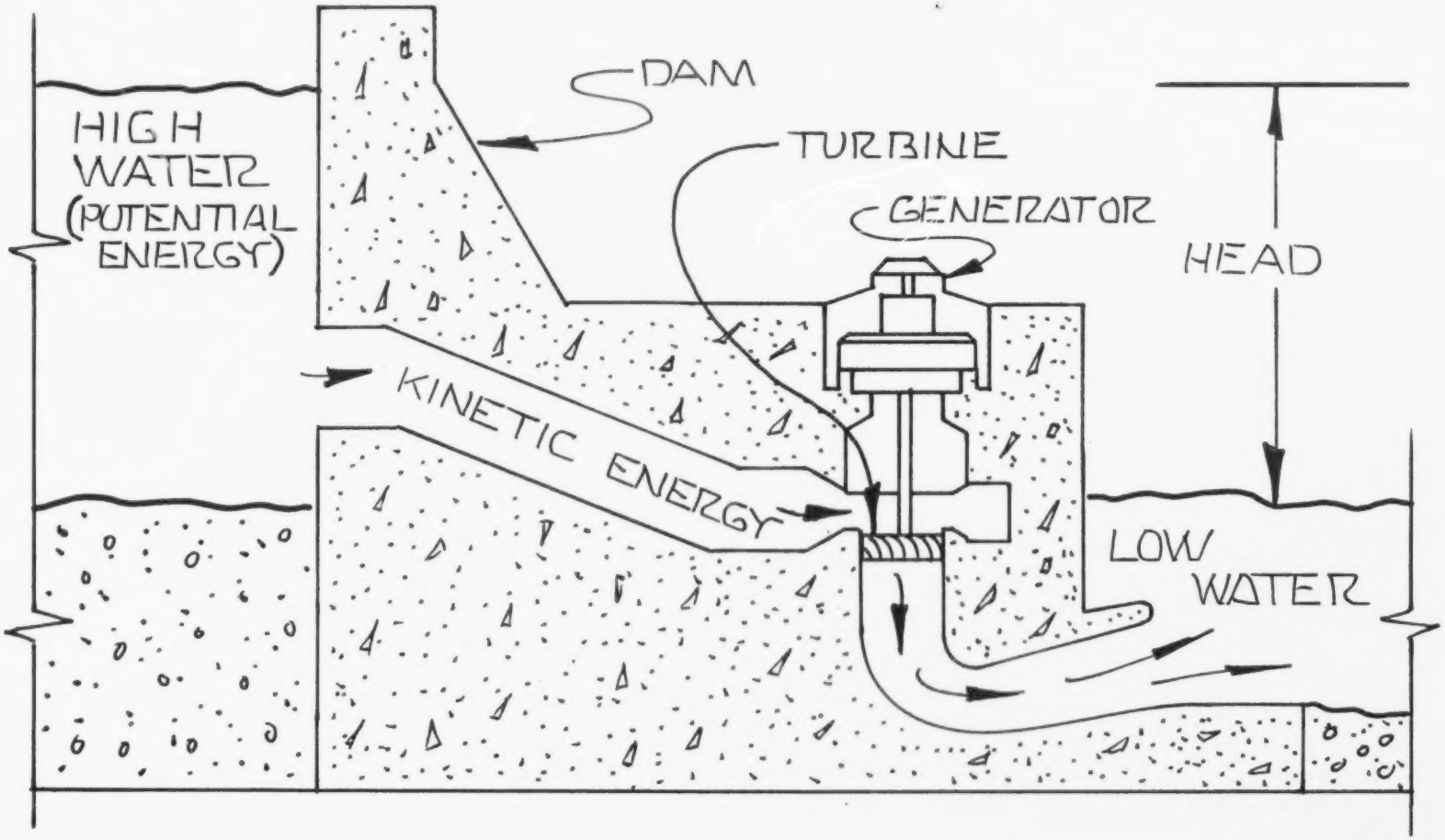
2. It is difficult to create enough pressure to turn more than a slow moving paddle wheel. Therefore, this activity makes use of the pressure provided by your community's water departments. Water departments often use a water tower to create pressure needed to distribute water throughout a community. The water tower uses gravity in much the same way as a hydroelectric power plant. Explain how the water tower is playing the role of a dam in your simulation. The tap allows you to release water from the dam in a controlled manner. Explain the role of the other simulation components during the demonstration.

3. During the simulation, have the students change the water pressure by opening and closing the tap. Also, have them monitor the effects these changes have on output energy. Be careful not to allow them to create so much pressure that hoses begin to pop off fittings. When students have completed their simulations, consider displaying one of the water power simulators in a location where the rest of the school community can see the results of your students water power investigation.

4. To help your students gather market information, consider using the market survey provided in this unit. Have students show prospective customers their prototype and ask them the questions listed on the survey. Possible survey subjects could include students, parents, teachers, neighbors and relatives. The market survey may need to be modified to accomodate your students' specific products.

FIGURE 6-1, WATER DISTRIBUTION SYSTEM




DAM
TURBINE
GENERATOR
HEAD
HIGH WATER (POTENTIAL ENERGY)
KINETIC ENERGY
LOW WATER

OT #6-4

WATER POWER

Discussion:

Moving water contains mechanical energy that can often be converted into electrical energy. Examples of harnessable moving water include waves, tides, river currents, ocean currents, and water released from a dam.

Hydroelectric Energy:

The energy in water flowing down a hill varies due to changes in water flow. The flow of water can be controlled with a dam. Water power plants that use dams are called hydroelectric power plants. The dam stores water that can be released in a consistent manner. Released water is used to turn turbines. The turbines convert the linear mechanical energy in the moving water into rotary mechanical energy. The rotating turbines are used to drive generators. The generators convert the mechanical energy from the turbines into electrical energy.

Sites for large scale hydroelectric power plants are very limited. A good location for a hydroelectric power plant must have a high rate of water flow. The site must also have the ability to store a lot of water. In addition, the site must be able to create a large head. The head is the distance between the top of the stored water and the bottom of the dam where the water will be released. In order to be useful, the hydroelectric plant must be near population centers. Lastly, hydroelectric power plants are located in areas that have heavy rainfall.

Most of the plans to build new hydroelectric power plants in the United States have been stopped. Many people are concerned about the effects hydroelectric power plants have on scenic rivers and the surrounding wildlife. For example, salmon need to swim upstream every year to spawn. Fish ladders have to be built to enable the salmon to swim over the dam. Unfortuantely, the number of salmon able to make the trip up stream has been reduced despite the fish ladders. Once a dam is built, farmland, forest, wildlife habitats, and even communities are flooded. Most of the dams in the United States over 25 feet tall are not being used to generate electricity.

Hydroelectric power is very efficient. Eighty-five to ninety percent of the energy in the moving water can be converted into electricity. Electricity from hydroelectric power plants is the cheapest kind of electrical energy available. Best of all, hydroelectric power plants do not pollute the water or the air.

Energy from Tides:

Tides are another form of moving water that can be used to generate electricity. Tides are caused by the gravitational force between the earth and the moon. The moon pulls the oceans away from the earth causing a bulge. As the earth rotates, the pulling action causes the bulge to move, and this produces tides. The energy in the tides can be harnessed by building a dam across a bay or estuary. When the tide is high the dam is closed and the tide water is trapped. When the tide goes out there is a difference in water level between the water behind the dam and the low tide water. When the water behind the dam is released, it is used to turn turbines. The turbines are linked to generators that convert the water's mechanical energy into electrical energy.

There are about 24 places in the world where tidal power can be harnessed. The site must experience a five foot change in water level for it to be worthwhile for a tidal power plant. The United States has only two good sites for tidal energy. One site is the Cook Inlet in Alaska and the other is Passamaquaddy Bay in Maine.

Wave Energy:

Waves are caused by the wind, and solar energy creates the wind. Therefore, waves are another form of solar energy. The energy in waves is very difficult to harness. Great Britain and Japan seem to be the only two countries that feel the wave energy available to them is worth serious research. Scientists are still experimenting with ways to harness the energy in waves. It will be some time before wave energy is a developed technology.

Ocean Current Energy:

Another idea still on the drawing board is the idea of harnessing ocean currents. Engineers hope to someday anchor giant turbines under water in the path of the Gulf Stream. The Gulf Stream is along the Florida coast. The ocean currents will pass through the turbines like the wind passes through a wind turbine. The ocean current will cause the turbines to turn and generators will produce electricity. The energy available in the Gulf Stream is estimated to have 50 times more energy than all the rivers in the world put together.

Moving water contains mechanical energy that can be used to generate electricity. Examples of moving water include rivers, streams, water released from dams, ocean currents, tides, and waves. During the energy conversion process, moving water is used to drive turbines. The rotating turbines are used to drive generators that convert mechanical energy into electrical energy. Examples of water power technology include hydroelectric power, tidal power, wave power, and ocean current energy. Water power is efficient, nonpolluting, and inexpensive. However, the number of sites where water power can be tapped are very limited.

Learning Activities:

To generate electricity with water power, the mechanical energy in the moving water must be converted to electrical energy. During the following learning activities, you will be conducting a water power energy conversion simulation. In addition, you will use the knowledge gained during the simulation to complete a flow chart illustrating the water power energy conversion process.

1. To conduct a water power energy conversion simulation, you will need the following materials:

   * one turbine/generator assembly
   * one volt meter and/or milliamp meter
   * two jumper leads
   * one length of rubber hose, about 20" long
   * access to a water source

2. If you are conducting your simulation indoors, place your turbine/generator in a baking pan. During the simulation, make every effort to keep water inside the pan (see Figure 6-2).

3. Using the jumper leads, connect the generator to a volt meter or milliamp meter. Connect the positive terminal of the generator to the positive terminal of the meter. Connect the negative terminal of the generator to the negative terminal of the meter. Turn the turbine shaft in the same direction it will be turned in the simulation. The needle on your meter should move. If it does not move, switch the wires on the meter. Try rotating the turbine shaft again. If the needle still does not move, ask your instructor for assistance.

4. Connect your turbine/generator assembly to a water source using the rubber hose. Make sure the hose will not slide off its fittings when the water pressure is applied to the system.

5. When your simulation is set up and your instructor has approved it, open the tap slowly and apply water pressure to your turbine. When your turbine begins to rotate, read your meter, and record the voltage or current in the space below.

_____

6. Increase the pressure being applied to your turbine. Read your meter and record the voltage or current in the space below.

_____

7. As water pressure increases, energy output from the turbine/generator _____.

   A. increases
   B. decreases
   C. stays the same.

8. Complete the flow chart illustrated below by matching the water power elements (listed at the top) with their proper location in the water power energy conversion process.

A. The rotating turbine is used to drive a generator

B. A force is applied to a body of water to cause it to move.

C. The electrical energy is distributed to the customer through a distribution grid.

D. Utility customers use electrical energy to perform work.

E. The mechanical energy in the moving water is used to drive turbines.

F. Generators convert the mechanical energy to electrical energy.

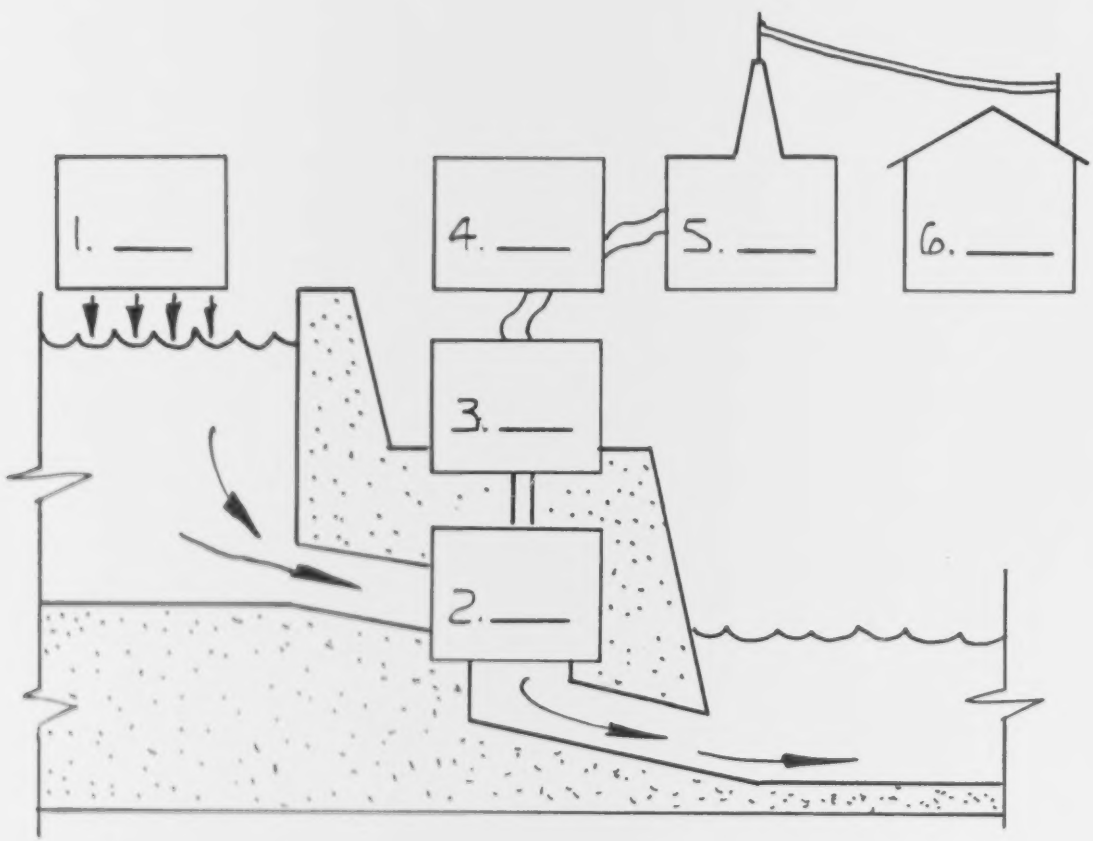
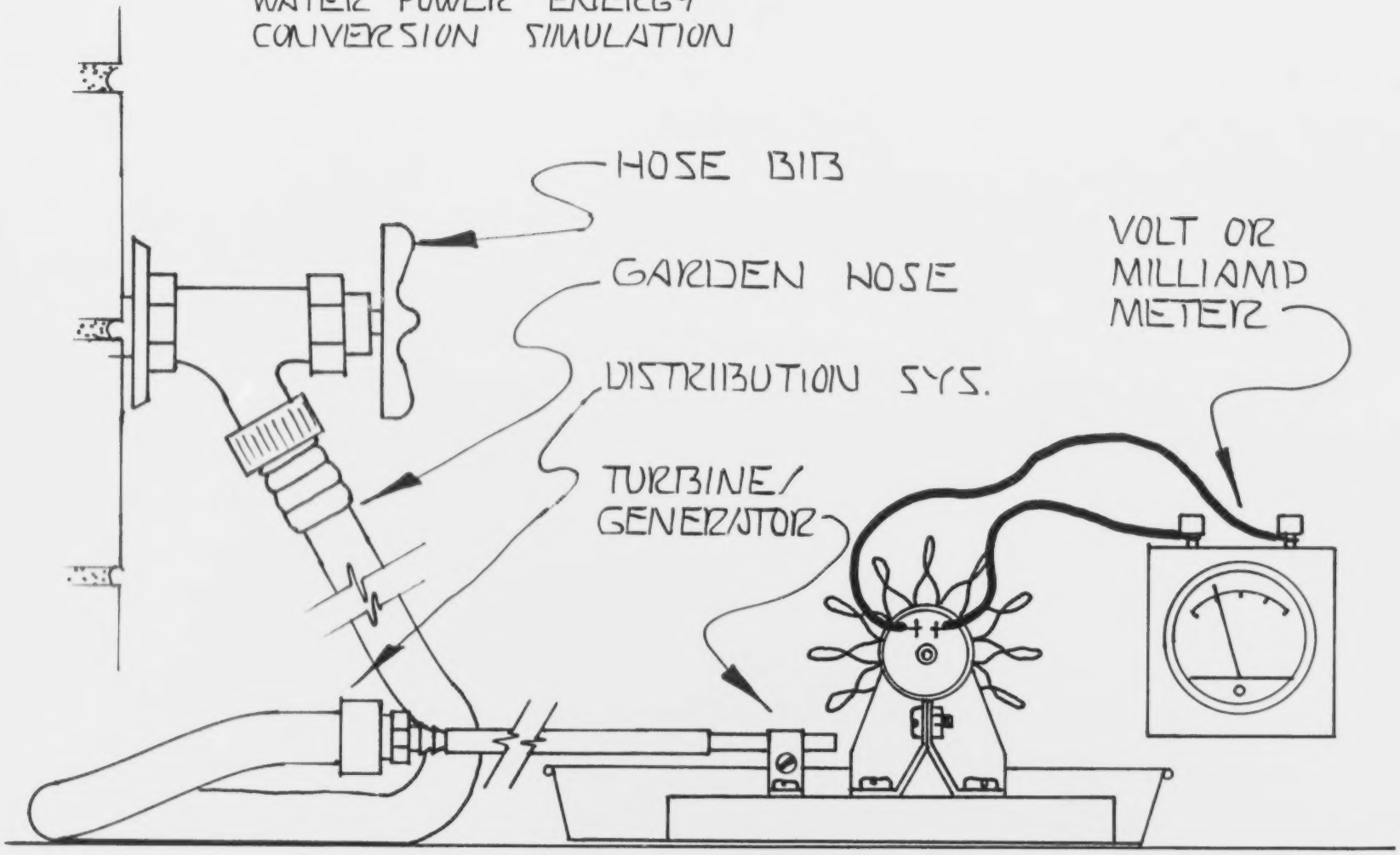


FIGURE 6-2, CONDUCTING A WATER POWER ENERGY CONVERSION SIMULATION



Unit: Using Alternate Energy Sources

Lesson 7: Nuclear Energy

Objectives	Lesson Content	Learning Activities	Ref.
A. Following a discussion, students will be able to: -identify a definition for nuclear energy -identify the correct sequence for the four steps in the nuclear fuel cycle. -identify a description of the fission process. -identify the two basic applications for nuclear energy. -identify the advantages and disadvantages of nuclear energy.	A. Nuclear Energy 1. The energy released when a uranium atom is split is called nuclear energy. 2. The nuclear energy fuel cycle a. mining -surface mining -deep mining b. refining c. fission d. disposing of nuclear waste 3. Fission Process a. splitting the uranium atom b. chain reaction c. producing steam d. driving turbines e. generating electricity 4. Applications a. generating electricity b. powering large ships 5. Advantages a. no air pollution b. nuclear power plants are inexpensive to operate c. uranium mining causes less land disruption than coal mining d. good supply of uranium in the U.S.	A. Teacher Guided Discussion 1. Ask students to identify the closest nuclear power plant to your community. 2. Using OT #7-1, discuss a definition for nuclear energy. 3. Using OT #7-2, discuss the nuclear fuel cycle. 4. Using OT #7-3, discuss the fission process. 5. Using OT #7-4, identify the two basic applications for nuclear energy. 6. Using OT #7-5 and 7-6, discuss the advantages and disadvantages of nuclear energy	

6. Disadvantages
   a. nuclear waste
   b. high cost of constructing new power plants
   c. thermal water pollution

B. Following a demonstration, in a lab activity, students will be able to:
-construct a power plant simulator according to written and verbal instructions.
-conduct a nuclear energy conversion simulation.
-accurately complete a flow chart illustrating the nuclear energy conversion process.

B. Conducting a nuclear energy simulation.
1. Making a power plant simulator
   a. connecting hobby motors
   b. connecting a load device
   c. connecting a power source
2. Conducting the simulation
   a. identifying the role of simulation components
   b. conducting the simulation
   c. measuring voltage and current
   d. determining simulator efficiency
3. Completing the energy conversion flow chart

B. Learning Activities
1. Demonstrate how to use the tools and materials to make a power plant simulator
2. Demonstrate how to make a power plant simulator.
3. Explain how to set up a nuclear power plant simulation. Explain how to connect a power source, volt meter, milliamp meter, and load device to the power plant simulator.
4. Demonstrate how to conduct a nuclear power plant simulation. Explain how to measure current, voltage, and how to determine simulator efficiency.
5. Provide each student with HO #7-1.
6. Divide your class into groups of three to four students. Assign each group a work station.
7. Have students begin making their nuclear power plant simulators.
8. Circulate around the room and provide individual instruction as needed.
9. When students have finished their simulators, have them set up and conduct a nuclear power plant.

10. When students have finished their simulation, have them complete their flowcharts.
11. Collect and evaluate your students lab sheets, simulators, and flowcharts.

OT #7-1

NUCLEAR ENERGY:

the energy released when a uranium atom is split.

OT #7-2

THE NUCLEAR ENERGY FUEL CYCLE:

* mining - surface and deep
* refining
* fission
* disposing of nuclear waste

OT #7-3

FISSION PROCESS:

* splitting the uranium atom
* chain reaction
* producing steam
* driving turbines
* generating electricity

OT #7-4

APPLICATIONS:

* generating electricity
* powering large ships

OT #7-5

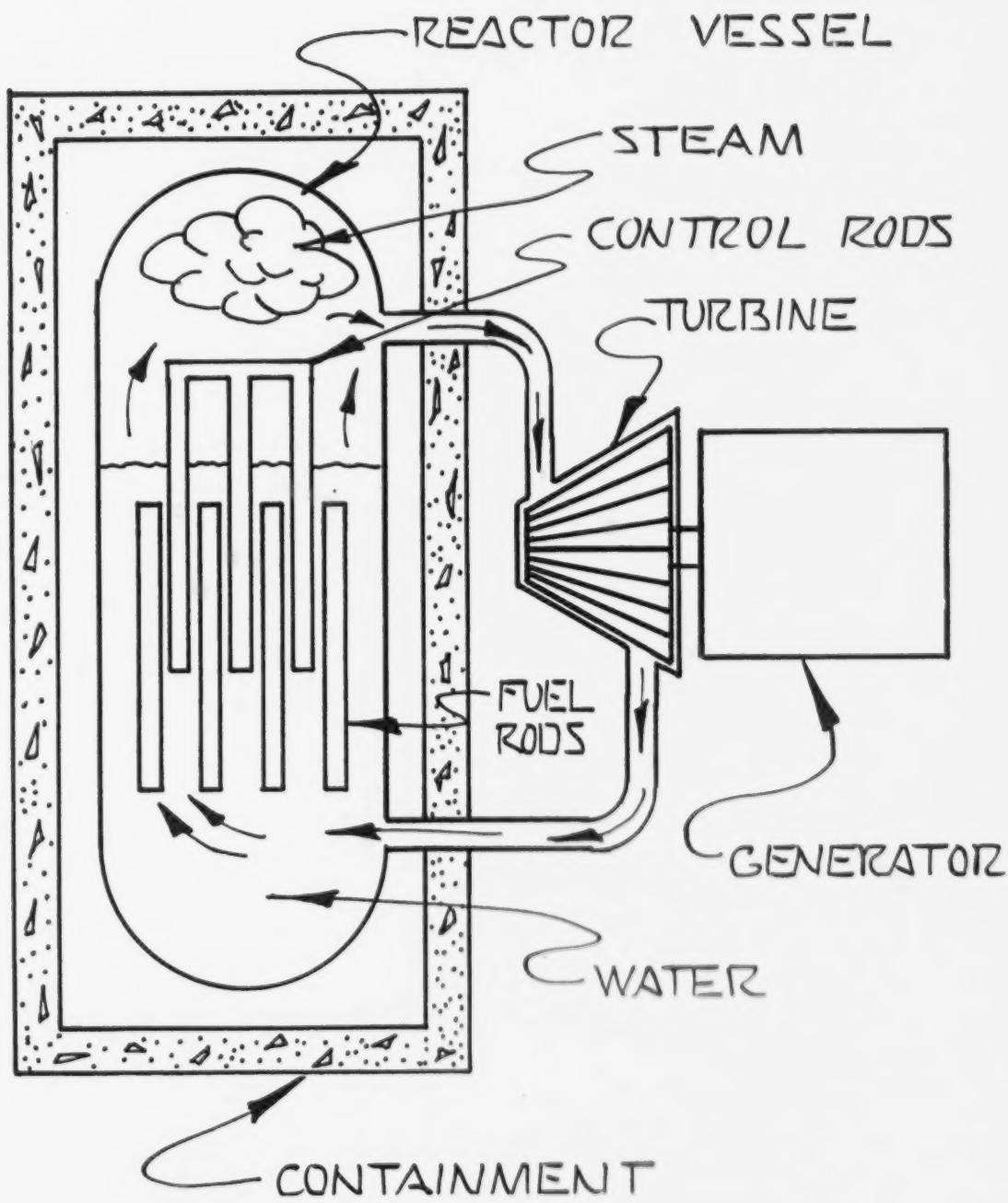
ADVANTAGES:

* no air pollution
* nuclear power plants are inexpensive to operate
* uranium mining causes less land disruption than coal mining
* good supply of uranium in the U.S.

OT #7-6

DISADVANTAGES:

* nuclear waste
* high cost of constructing power plants
* thermal water pollution


REACTOR VESSEL
STEAM
CONTROL RODS
TURBINE
FUEL RODS
GENERATOR
WATER
CONTAINMENT

NUCLEAR ENERGY

Preparation Hints:

1. Review the materials provided, duplicate HO #7-1, and prepare the transparencies needed to present this lesson.

2. During the lab activity, your students will be making and testing a nuclear power plant simulator. Prior to implementing this lesson, you will need to collect and organize the materials listed in the handout. Hobby motors can be purchased through many of the industrial arts and science vendors. Hobby shops are also a good source for small motors. The motors should have a 3 to 6 volt rating. They may cost anywhere between fifty cents and several dollars. The meters needed for this lab activity can often be borrowed from your school's science department. You can purchase test leads and light bulbs (LED's) from an electronics supplier.

3. Consider making a nuclear power plant simulator and performing the lab activity prior to implementing this lesson. Making the simulator and conducting the lab will enable you to test your materials, identify problems, and develop strategies to ensure student success. In addition, students will be able to refer to your example when making their own simulators.

Content Presentation Hints:

1. Consider showing your students a film or videotape on nuclear energy. Many of the utilities companies in Illinois have produced films that can be loaned to your school. Contact the utility company in your area and see if they have a film appropriate for your class. Most of the film loaning organizations also have films about nuclear energy. You may need to look under "science" to find an appropriate film.

2. Have a guest speaker from your local utility company come in and talk to your students about nuclear energy. Many of the utility companies in Illinois have a public relations program that will provide your school with a guest speaker. Presenters often come equipped with visual aids, tokens from their company, and learning activities.

3. Consider conducting a field trip to a nuclear power plant. Illinois has many plants, and one may be near you. Contact your local utility company to see if they have a tour program. Organizing a field trip of this kind is a lot of work. Therefore, you may want to work with your school's science department when facilitating a field trip.

4. To demonstrate a chain reaction, consider conducting the following demonstration. Obtain a large box and fill the bottom with mouse traps. After all the mouse traps have been set, toss a ping pong ball into the box. The ping pong ball entering the box should start a chain reaction, tripping most of, if not all, the mouse traps. Explain how the demonstration represents the chain reaction during the fission process.

Learning Activity Hints:

1. The purpose of the lab activity is to allow students to experience the energy conversion sequence that occurs in most nuclear power plants. In addition, students can discover why electricity is called "a second generation energy resource."

2. During the lab activity, students will construct an experiment with a simple power plant simulator. The simulator will use a battery for an input energy resource. Since the context of this lesson is nuclear energy, the battery will represent a nuclear reactor containing uranium. However, the battery can just as easily be used to represent a boiler fueled by coal, petroleum, or natural gas. The turbine and generator will be represented by the two hobby motors linked together. A small light bulb or LED will be used to represent the customers served by the power plant.

3. Demonstrate how to measure voltage and current with meters. Explain how to calculate power and efficiency. You may want to do several examples on the board. Review the procedures listed on the lab sheet with your students.

4. After students have completed the lab, discuss the observations and conclusions students were able to make during the lab activity. Discuss the efficiency of the simulator in contrast to the efficiency of a real power plant. Include in your discussion hydroelectric, coal, petroleum, and nuclear power plants. Use a monitary analogy to explain the concept of efficiency. For example, most nuclear power plants are between forty

and fifty percent efficient. Therefore, a dollar's worth of uranium results in 40 to 50 cents of electrical energy. Fifty to sixty percent of the energy in the uranium fuel is typically not tapped.

NUCLEAR ENERGY

Discussion:

Nuclear energy is released when an atom of matter is split. Matter is basically any material. The matter used most for nuclear energy is called uranium 235. In terms of energy, one ton of uranium 235 is equal to 320,000 tons of coal.

Uranium is a material that is found in the earth. Uranium is removed from the earth by means of underground or surface mining techniques. Only a fraction of the uranium mined can be used in a nuclear power plant. After the uranium has been mined, it must be refined before it can be used in a power plant. Just like fossil fuels, someday we will run out of uranium.

Splitting a uranium atom causes other uranium atoms to split in a chain reaction. This chain reaction must be carefully controlled and contained. The energy released during the chain reaction is called fission. The fission process creates a lot of heat. The heat is used to produce steam. The steam is used to drive turbines. The turbines turn a generator that converts mechanical energy into electrical energy.

Containing the chain reaction is very important. Without containment, the heat and radiation produced during the chain reaction would escape. For safety pruposes, the inner walls of a nuclear reactor are often made out of steel between 9 and 12 inches thick. The outer walls are made out of reinforced concrete several yards thick.

Once a chain reaction starts, the operators of a nuclear power plant must be able to control it. In an emergency, the operators must be able to stop the chain reaction. When a uranium atom is split, it releases neutrons. Before the atom was split, the neutrons were part of the atom's center. The released neutrons travel at a speed of about 7000 feet per second. Part of the controlling process is to slow these neutrons down. A material like water or graphite is used in the reactor to slow the neutrons down.

Another part of the controlling process is being able to absorb neutrons released during the chain reaction. A nuclear reactor contains control rods. The control rods are made out of a material that absorbs neutrons. Putting a part of the control rods into the chain reaction enables the

operators to control the chain reaction. Putting all of the control rods into the chain reaction causes the chain reaction to stop.

The most common use for nuclear energy is generating electricity in a power plant. However, nuclear energy can also be used to power large ships. Aircraft carriers, submarines, and some commercial ships are powered by nuclear energy.

After nuclear fuel has been used, it must be handled carefully because it is radioactive. The used fuel must first be stored in water for several months. During this temporary storage, its radioactivity has been reduced by more than 90 percent. After the radioactivity has been reduced, the used fuel can be shipped to a new storage site. Used fuel still contains useful by-products that can be made into new fuel. After the useful by-products have been removed, nuclear waste is left over. The waste must be stored in a location where it will be safe for millions of years. One method of storing nuclear waste is burying it underground in salt formations. Another method being proposed for storing nuclear waste is to bury it in the ocean floor. Only a fraction of the nuclear waste produced comes from nuclear power plants. Most of the nuclear waste is the result of making nuclear weapons.

Nuclear energy has several advantages. Once a nuclear power plant has been built, operating the plant is very inexpensive. Because nothing is being burned, nuclear power plants do not pollute the air. Mining uranium causes less damage to environment than mining coal. The United States has a good supply of uranium.

Nuclear energy has several disadvantages. Nuclear power plants use water from rivers or lakes to cool the reactor. The water leaving a nuclear power plant is very hot. Dumping hot water into a river or lake can damage its animal and plant life. Nuclear power plants have become very expensive to build. Because of their high cost, most of the plans to build new power plants have been cancelled. Lastly, nuclear waste is a big problem for the United States. Many states have created laws to prevent the storage of nuclear waste in their state.

The energy released when a uranium atom is split is called nuclear energy. During the fission process, uranium atoms are split in a chain reaction. This reaction releases energy that can be used to produce steam. The steam in turn, is used to drive a turbine/generator which generates electricity. Common applications for nuclear energy include generating electricity and powering large ships. The

advantages of nuclear energy include no air pollution, low power plant operating costs, limited land disruption during mining operations, and the United States has its own supply of uranium. However, nuclear waste, the high cost of building nuclear power plants, and thermal water pollution have made nuclear energy a controversial energy resource.

Learning Activity:

To generate electricity with nuclear energy, the energy released when a uranium atom is split needs to be converted into mechanical energy, and the mechanical energy must be converted to electrical energy. During the following learning activities, you will be making and testing a simple nuclear power plant simulator. In addition, you will determine your simulator's efficiency, and complete a flowchart illustrating the nuclear energy process.

Making and Testing a Nuclear Power Plant Simulator:

1. To make a nuclear power plant simulator, you will need the following materials:

   * two small hobby motors
   * one six volt battery
   * one milliamp meter
   * one volt meter
   * one small light bulb or LED
   * five test leads with alligator clips
   * precut pieces of wood for the power plant platform
   * one piece of wire insulation about 1/2" long
   * two nylon wire ties

2. Using the wire insulation, link the two hobby motors together as illustrated in Figure 7-1. Assemble the wooden base for your nuclear power plant simulator according to your teacher's instructions. When it is finished, position the two hobby motors on the base. Fasten the motors in place with nylon wire ties.

3. Using jumper leads, connect a light bulb or LED to one of the motors (see Figure 7-2). Using a second set of jumper leads, connect the other motor to the six volt battery. To turn your simulator on and off, simply remove one of the jumper leads on the battery. When all the connections have been made, your simulator should be running and the light bulb or LED should be lit. If you are using a LED as a light source and it is not lit, try switching the jumper leads. If your LED still does not light, ask your instructor for assistance.

Conducting a Nuclear Power Plant Simulation:

1. With the simulator running, measure the voltage across the battery using a volt meter. Touch the positive test lead to the positive terminal of the battery. Touch the negative test lead to the negative terminal on the battery. Read the meter and record the voltage in the space below.

   _____ volts

2. Measure the current flowing between the battery and the first hobby motor with a milliamp meter. Connect the positive test lead to the positive terminal on the battery. Connect the negative test lead to the jumper wire coming from the hobby motor. Read the meter and record the current in the space below.

   _____ milliamps

3. Using the formula below, calculate the amount of power being used by the first motor.

   Power = voltage x current

   Power = _____ x _____

   Power = _____

4. Measure the voltage across the light bulb with a volt meter. Touch the positive test lead to the positive terminal on the light bulb. Touch the negative test lead to the negative terminal on the light bulb. With the simulator running, read the meter and record the voltage in the space below.

   _____ volts

5. Measure the current between the motor and the light bulb with a milliamp meter. Connect the positive test lead to the positive terminal of the motor. Connect the negative test lead to the jumper wire going to the light bulb. With the simulator running, read the meter and record the current in the space below

   _____ milliamps

6. Using the formula below, calculate the power being used by the light bulb.

   Power = voltage x current

   Power = _____ x _____

   Power = _____

7. Calculate your simulator's efficiency using the formula listed below.

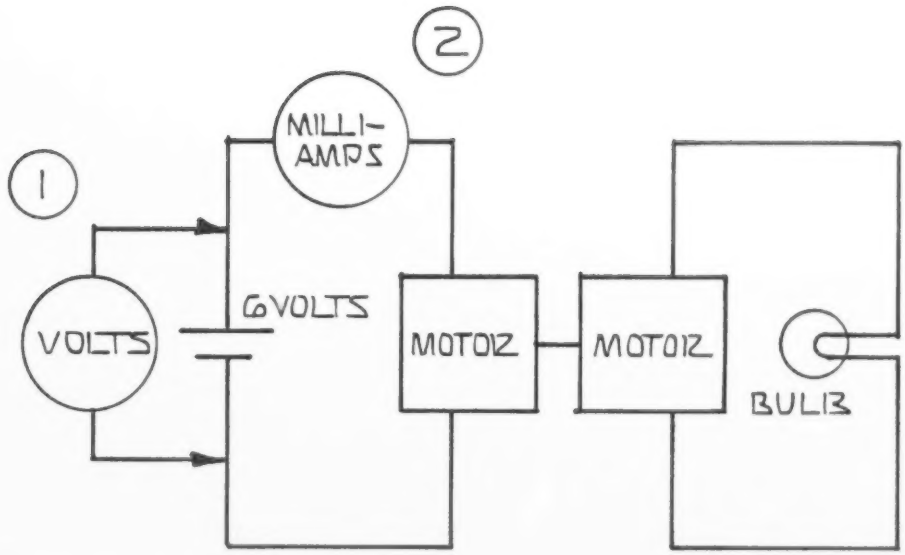
   Efficiency = output power/input power x 100

   Efficiency = _____/_____ x 100

   Efficiency = _____

8. The amount of input energy needed to generate electricity is _____ the amount of energy produced.

   A. greater than
   B. less than
   C. equal to


2
MILLI-
AMPS
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VOLTS
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MOTOR
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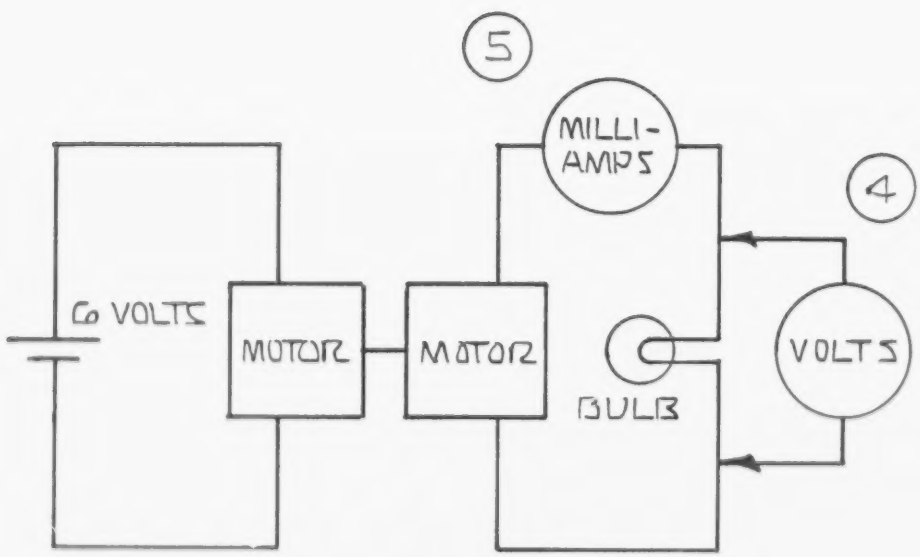
BULB


5
MILLI-
AMPS
4
6 VOLTS
MOTOR
MOTOR
BULB
VOLTS

9. Complete the flowchart illustrated below by matching the nuclear energy elements (listed at the top) with their proper location in the nuclear energy conversion process.

A. The energy released during the chain reaction is used to produce steam.

B. The generator converts the mechanical energy into electrical energy.

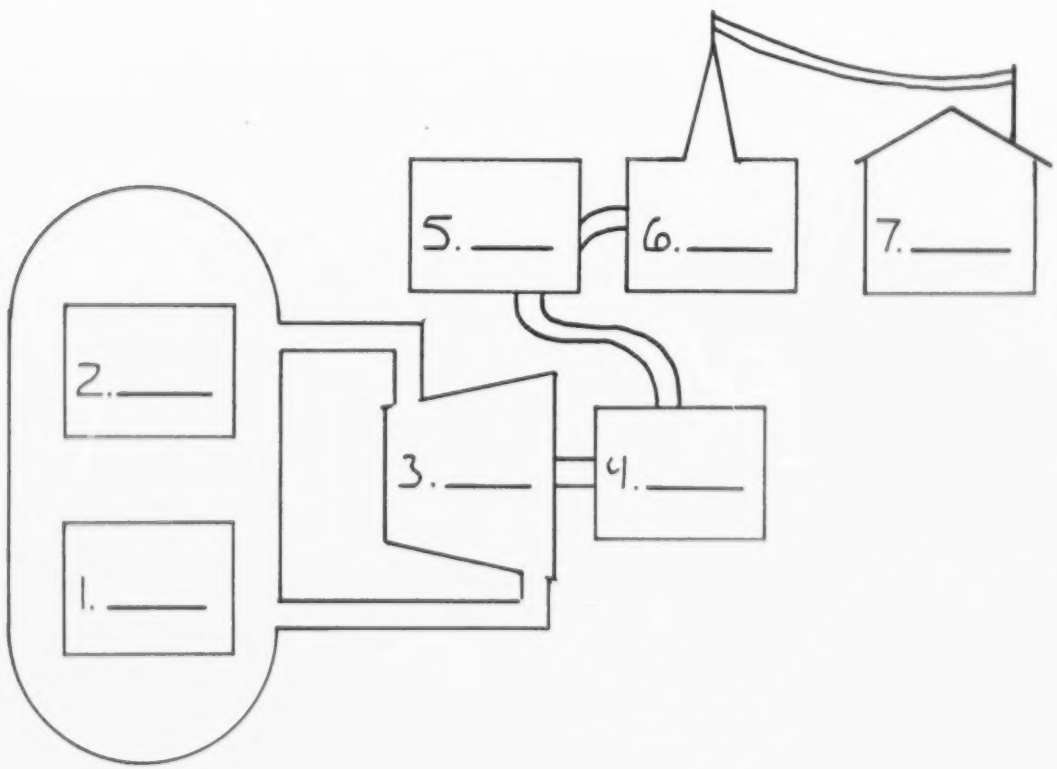
C. Energy is released when uranium atoms are split during a chain reaction.

D. The rotating turbine is used to drive a generator.

E. The mechanical energy produced by the steam is used to turn a turbine.

F. The utility company's customers use the electricity to perform work.

G. The electrical energy is distributed to the utility company's customers through a distribution grid.



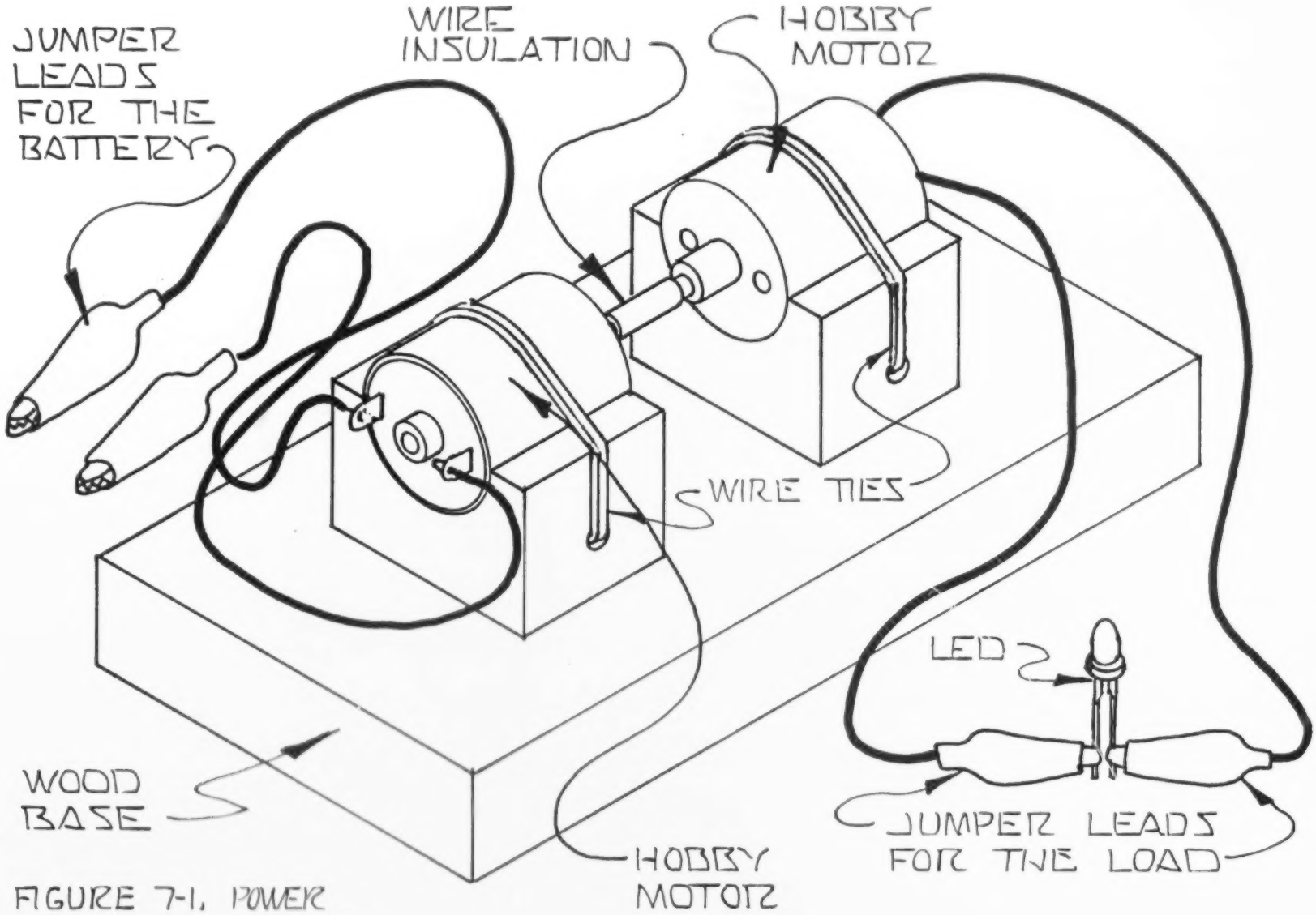


FIGURE 7-1. POWER PLANT MOCK-UP

UNIT: Using Alternate Energy Resources

LESSON 8: Evaluation

Objectives	Lesson Content	Learning Activities	Ref.
A. Following a review, students will be able to complete given concept statements regarding using alternate energy sources with a minimum of 70% accuracy.	A. Review 1. Wind Energy 2. Ocean Thermal Energy Conversion 3. Water Power a. hydroelectric power b. tidal power c. wave energy d. ocean current energy 4. Geothermal Energy 5. Biomass Energy 6. Nuclear Energy	A. Teacher Guided Review 1. Review the major concepts explored in this unit. 2. Provide students with an opportunity to ask questions before taking the test. 3. Provide students with HO #8-1. Make sure each student has a pen or pencil. 4. Explain the directions for the test. 5. Have students read the test and answer questions provided. 6. Collect the tests and grade your students' performance. 7. Provide the students feedback regarding their test performance as soon as possible.	

REVIEW AND EVALUATION

Review:

Review the major concepts addressed during the unit. Include in your review wind energy, OTEC, water power, geothermal energy, biomass energy, and nuclear energy sources. Have students participate in the review by asking and/or answering questions.

Administering the Test:

Have students sit in their assigned location for a test. Provide each student with HO #8-1. Make sure each student has a pen. Explain the directions for the test. After all questions regarding the directions have been answered, have your students begin taking the test. Circulate around the classroom and provide individual help if appropriate. Collect the test at the end of the class period. Evaluate each student's performance on the test. Provide your students with feedback regarding their performance on the test as soon as possible.

USING ALTERNATE ENERGY SOURCES
UNIT TEST

DIRECTIONS: Read each statement carefully. Circle the letter of the answer you think answers the question best.

1. Which of the following is a fossil fuel?

   A. coal
   B. hydroelectricity
   C. nuclear energy
   D. solar energy

2. Which of the following is a renewable energy resource?

   A. natural gas
   B. OTEC
   C. biomass energy
   D. wind energy

3. One disadvantage to large scale windplants is ____.

   A. air pollution
   B. sight pollution
   C. water pollution
   D. noise pollution

4. Wind energy can be used to ____.

   A. pump water
   B. generate electricity
   C. power boats
   D. all of the above

5. The most promising use of wind energy is ____.

   A. small privately owned windplants
   B. large scale windplants owned by utility companies
   C. is putting several windplants on a wind farm
   D. none of the above

6. An increase in wind will ____.

   A. cause a decrease in energy output
   B. cause an increase in energy output
   C. not affect the energy output
   D. cause the windplant to fail

7. Using the difference in temperature between surface water and deep water to generate electricity is ____.

A. hydroelectricity
B. energy from the tides
C. energy from the wave
D. ocean thermal energy conversion

8. Geothermal energy is basically energy from the ____.

A. ground
B. air
C. ocean
D. sun

9. Waste water from a geothermal power plant is ____.

A. used for drinking water
B. put back into the ground
C. dumped into rivers or lakes
D. stored in large ponds

10. Geothermal energy deposits are commonly found in ____.

A. areas close to the ocean
B. flat inland areas
C. earthquake and volcano areas
D. mountainous areas

11. The turbines in a geothermal power plant are driven by ____ under high pressure.

A. air
B. water
C. gases
D. steam

12. Which of the following energy resources are indirect forms of solar energy?

A. wind energy
B. biomass energy
C. energy from waves
D. all of the above

13. The force between the earth and moon causes ____.

A. waves
B. tides
C. water falls
D. river currents

14. Hydroelectric power plants affect the environment in the form of ____.

A. water pollution
B. air pollution
C. sight pollution
D. all the above

15. Hydroelectric power plants are commonly located in ____.

A. mountainous areas
B. coastal areas
C. flat inland areas
D. the mouth of rivers

16. The two possible sites for tidal energy in the United States are in ____.

A. California and Oregon
B. Rhode Island and Hawaii
C. Alabama and Florida
D. Alaska and Maine

17. Plants store energy from ____.

A. the ground
B. the sun
C. rain water
D. fertilizer

18. The most commonly used form of biomass energy is ____.

A. gasohol
B. firewood
C. manure
D. corn

19. Energy resources that can NOT be used up and will always be available are called ____.

A. renewable
B. nonrenewable
C. inexhaustible
D. secondary

20. Nuclear power plants ____.

A. do not pollute the air
B. are inexpensive to build
C. do not pollute the water they use
D. use a nonrenewable fuel

USING ALTERNATE ENERGY SOURCES

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-"Networks: How Energy Links People, Goods and Services"
-"Solar Energy"
-"Nuclear Energy"

IMPORTANT ADDRESSES

Energy Research and Development Administration, Technical Information Center, P. O. Box 62, Oak Ridge, TN 37830.

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